APRIL, 1941.

GENERAL PHYSICS.

ATOMIC AND MOLECULAR STRUCTURE.

435. Molecular distribution. J. E. MAYER AND E. MONTROLL. *J. Chem. Phys.*, **9**, *pp.* 2–16, *Jan.*, 1941.—Various functions, by means of which the distribution of molecules in a system may be described, are defined and the relations between them are derived. Equations, by means of which these functions may be calculated from a knowledge of the mutual potential energy between pairs of molecules, are also derived. The equations applicable to gaseous systems, which are derived by a development previously used in the theory of condensing systems, make possible the calculation of the distribution functions by means of a power series in either the fugacity or the inverse volume. The coefficients of these power series are direct integrals involving the pair potentials between molecules. In condensed systems an alternative procedure is required. The equations then appear in the form of integral equations. By the use of functions involving the probabilities of population of virtual cells the cell equation used for the calculation of the thermo-dynamic properties of liquids is derived. The direct connection between the equations in the theory of condensing systems and those in the cell approximations is thus established. AUTHORS.

436. Influence of intra-molecular atomic motion on electron diffraction diagrams. P. DEBYE. *J. Chem. Phys.*, **9**, *pp.* 55–60, *Jan.*, 1941.—The author discusses the influence of atomic vibrations and of free or hindered rotations of molecular groups in molecules on their scattering properties. The radial distribution curve is calculated and the results which may be expected from an analysis of this curve are indicated. AUTHOR.

437. Force constants in some organic molecules. B. L. CRAWFORD, JR. AND S. R. BRINKLEY, JR. *J. Chem. Phys.*, **9**, *pp.* 69–75, *Jan.*, 1941.—Consistent normal co-ordinate treatments, involving force constants which are related to bond structures and which may be transferred from one molecule to another, are applied to hydrogen cyanide, methyl cyanide and the methyl halides. A table of force constants for a number of bond structures is given. The structural significance of these constants is briefly discussed. [See Abstr. 2094 (1939).] AUTHORS.

438. Mathematical methods for the study of molecular vibrations. E. B. WILSON, JR. *J. Chem. Phys.*, **9**, *pp.* 76–84, *Jan.*, 1941.—Developments which reduce the labour of calculating the vibration frequencies of complex molecules are described. In particular, a vectorial scheme is given for obtaining the reciprocal of the matrix of the kinetic energy in terms of valence-type co-ordinates. A general rule for writing down the coefficients of the transformation to symmetry co-ordinates is derived together with a method of obtaining the kinetic energy reciprocal matrix in terms of symmetry co-ordinates. A treatment of redundant co-ordinates is developed. In addition, reduction of the secular equation by the splitting-out of high frequencies, a new type of isotope product rule and the determination of normal co-ordinates, are discussed. The molecule CH_3Cl is worked out. [See Abstr. 184 (1940).] AUTHOR.

439. Extended co-ordination theory of valency. II, III and IV. R. TSUCHIDA, M. KOBAYASHI AND H. KUROYA. *Rev. Phys. Chem. Japan*, **13**, 2, *pp.* 32–41 ; **13**, 3, 61–73, and **13**, 6, *pp.* 151–165, 1939. *Coll. Pap. Fac. Sci., Osaka Imp. Univ. C*, **7**, 1939.—Part II [see Abstr. 2667 (1939)] deals with the configuration of carbon compounds and extends the co-ordination theory of Werner to simple cases by regarding all the chemical bonds as co-ordinate links. The co-ordination number, therefore, coincides with the number of bonds. The configurations of various inorganic and organic compounds and the bond functions for them are given. Part III is concerned with valence bonds in carbon compounds, all of which are assumed to be formed by co-ordinating ions and molecules around quadrivalent carbon cations. According to the number and nature of the ligands, there are at least 6 types of bonds in carbon compounds, viz. tetrahedral, trigonal, aromatic, digonal, double and triple, and these are treated from the quantum mechanical standpoint. Part IV investigates the configuration of compounds of the transition elements, and the eigenfunctions of zero order for the formation of compounds of various co-ordination numbers are given. It is shown that the octahedral bond is the strongest of all the co-ordination bonds. When the composition of an ion or molecule of an element is given, it is shown how the electronic distribution, the magnetic moment and the external configuration, can be predicted in satisfactory coincidence with observed data. Finally, the relation between the configuration and the absorption spectrum is referred to. H. H. Ho.

440. Revisions of the covalent radii and the additivity rule for the lengths of partially ionic single covalent bonds. V. SCHOMAKER AND D. P. STEVENSON. *J. Amer. Chem. Soc.*, **63**, *pp.* 37–40, *Jan.*, 1941.—New values of the normal covalent single bond radii of H, N, O and F, are given which are consistent with the bond lengths in the H_2, hydrazine, H_2O_2 and F_2 molecules. The additivity rule for bond lengths is not generally valid but must be used with a correction for the effect of the ionic character of the bond. AUTHORS.

441. Relation between structure and free energy of organic molecules. P. F. BRUINS AND J. D. CZARNECKI. *Industr. Engng Chem.*, **33**, *pp.* 201–203, *Feb.*, 1941.—This paper demonstrates that each different kind of atomic linkage within a molecule of an organic compound definitely contributes to the free energy of formation of the whole molecule. Equations are derived from existing molecular free-energy equations to express the amount by which the free energy changes upon the formation of the following bonds : C—H, C—C, C=C, C—CH_3, C—OH, C—CHO, and C—COOH. AUTHORS.

See also Abstracts 588, 637.

COLLOIDS.

442. Determination of average molecular weights or particle sizes for polydispersed systems. E. O. KRAEMER. *J. Franklin Inst.*, **231**, *pp.* 1–21, *Jan.*, 1941.—Fine powders, colloidally dispersed material and most macromolecular substances, have non-homogeneous mol. wts and particle sizes so that usually average values for these quantities are obtained. But it has been shown [Abstr. 2347 and 3731 (1935)] that such average mol. wts differ in value depending on the method employed and on particle size. The types of average values yielded by the different methods are discussed and the conditions under which different averages may be calculated from each other are outlined. W. R. A.

443. Effect of supersonic waves on colloidal phenomena. V. Thixotropic systems. 1. $Al(OH)_3$. N. SATA AND N. NARUSE. *Coll. Pap. Fac. Sci., Osaka Imp. Univ. C*, **7**, 1939. *In German.* [Abstr. 1319 (1939).] **2. $Fe(OH)_3$.** N. SATA AND N. NARUSE. *Kolloid Zschr.*, **89**, 3, *pp.* 341–344, 1939. *Coll. Pap. Fac. Sci., Osaka Imp. Univ. C*, **7**, 1939. *In German.*—Thixotropic systems of Fe_2O_3 are considered, and the influence of supersonic waves on the setting times found to alter with varying salt concentrations and to exhibit a reversal with increase at smaller and decrease at higher concentrations. These effects are not only closely connected with states of hydration but also depend on particle form and orientation. **VI. Influence of supersonic vibrations on rotatory power of high-molecular substances. 1. Gelatin solutions.** N. SATA. *Coll. Pap. Fac. Sci., Osaka Imp. Univ. C*, **7**, 1939. *In German.* [Abstr. 2962 (1939).] **2. Tannin solutions.** N. SATA. *Coll. Pap. Fac. Sci., Osaka Imp. Univ. C*, **7**, 1939. *In German.* [Abstr. 4370 (1939).] H. H. Ho.

444. Colloid-chemical and physico-chemical properties of starch solutions. M. SAMEC. *Kolloid Zschr.*, **92**, *pp.* 1–8, *July*, 1940. *In German.*—The author gives 2 examples of methods used in the investigations on starches where the classical methods of organic chemistry are inadequate. The first deals with the part played by H_3PO_4 in the constitution and behaviour of starch. It appears that the contents of P_2O_5 are mainly responsible for the changes in viscosity, conductivity and *p*H, of highly dialysed potato starch sols subjected to a prolonged heating process. Methods for removing the P_2O_5 from starch are described and comparative X-ray spectra are given. The second example deals with an admixture of phosphorus and nitrogen compounds to potato and wheat starches and with the methods of cleaning the starch of these inorganic impurities. R. N.

445. Swelling of cellulose hydrates in the presence of protein substances. E. ELÖD AND G. SCHMITT. *Kolloid Zschr.*, **92**, *pp.* 105–112, *July*, 1940. *In German.*—The authors investigate the influence on the water-absorbing properties of viscose of adding proteins such as gelatin, casein and blood albumin. With increasing protein content the absorption decreases to a min. and then rises again. The phenomena are explained by reciprocal actions due to co-valency effects. The largest reduction of swelling was obtained by addition of blood albumin. A steady decrease of water absorption with rising protein contents may be reached by a tanning process ; the efficiency depends on *p*H value. R. N.

446. Applications of the kinetic theory to the behaviour of long-chain compounds. H. MARK. *J. Appl. Phys.*, **12**, *pp.* 41–44, *Jan.*, 1941.—When long-chain molecules pass from the extended into the contracted state, curling energy and curling entropy may be developed, and the present paper deals with these changes in connection with their effects on melting points, the swelling of long-chain compounds and the viscosity of diluted solutions of soft elongated particles. H. H. Ho.

447. Microscopic structure of the cotton fibre. C. W. HOCK, R. C. RAMSAY AND M. HARRIS. *Bur. Stand. J. Res. Wash.*, **26**, *pp.* 93–104, *Feb.*, 1941.—The cell wall of a cotton fibre consists of a primary and a secondary wall. The latter, which comprises the bulk of the fibre, consists of innumerable spirally oriented cellulose fibrils enclosed by a winding which also makes a spiral but in the opposite direction from the former. Both the winding and the fibrils reverse their direction at frequent intervals along the axis of the fibre, their points of reversal being coincident. The secondary wall is enclosed by a thin primary wall. The latter is made up of fine criss-crossing strands of cellulose embedded in a membrane consisting principally of wax and pectic substance. The lumen also contains wax and pectic materials plus various amounts of degenerated protoplasm. When cotton fibres are swollen under certain conditions, a lamellate structure is discernible in the secondary wall. The number of these lamellae increases with the age of the fibre. On treatment of cotton fibres with cuprammonium hydroxide reagent the cellulose dissolves, leaving residues which vary in amount and in structure, depending upon the extent of purification of the fibres. The residue from raw and from dewaxed fibres consists of fragments of the primary wall and of a lesser amount of material from the lumen. The behaviour of the fibres in the reagent depends in part on their maturity. Immature fibres containing only small amounts of cellulose swell relatively little in the reagent, and the undissolved wax and pectic materials maintain the original tubular shape of the primary wall. When older fibres are given the same treatment, they swell abruptly, thereby causing the primary wall to break in many places, giving rise to " balloons." Irregular swelling along the fibre axis, which results in the formation of balloons, appears to be dependent in part on the orientation of the fibrils and in part on the constricting influences of the winding and of the primary wall. AUTHORS.

448. Structure and properties of fat particles in human serum. A. C. FRAZER. *Trans. Faraday Soc.*, **37**, *pp.* 125–129, *March*, 1941.—Biochemical and physiological evidence supports the view that the particles seen in the blood under dark-ground illumination are essentially neutral fat. Their behaviour with fat solvents, precipitants and change of reaction, suggests a close association with protein, especially with the globulin fraction. The addition of protein to finely dispersed oil-in-water emulsion affords protection for the emulsion against salts and acid, which is probably due to the formation of a tough film of protein on the surface of the fat particle. The fat particles are also found to select the globulin from a mixture of albumin and globulin, so that a particle of fat added to the blood will be invested with a globulin film. Orientation of protein molecules occurs at the oil/water interface which may greatly modify their effects on the body cells. This modification may be seen in normal constituents, such as the agglutinins, or may be demonstrated by injection of hormones. Experiments on toxins and cobra venom illustrate the possible effect of the oil/water interface on these lethal substances, and it is suggested that the oil/water interface may also be of importance as a protection against the effects of bacterial toxins. H. H. HO.

449. Colloidal systems of 3 liquid components. N. SATA AND H. OKUYAMA. *Bull. Chem. Soc. Japan*, **14**, *pp.* 147–152, 1939. *Coll. Pap. Fac. Sci., Osaka Imp. Univ. C*, **7**, 1939. *In German.*—Emulsification phenomena between 2 liquids having the same sp. gr. have been investigated. Such 2-liquid systems were prepared from combinations of 3 liquids of different miscibilities and sp. gr., and the following systems were studied : benzene/water/carbon-tetrachloride ; water/amyl-alcohol(iso)/chloroform ; and water/methyl-alcohol/benzene. These mixtures at suitable concentrations give 2-liquid systems which possess the same sp. gr. but different boundary surface tensions ; the emulsification and coagulation depend upon boundary surface tension, viscosity and volume relationship. It was established by experiment that for the complete solution of the emulsification problem the influence of the gaseous phase and of the walls of the containing vessels must be taken into account. Similar results were obtained for supersonic-wave emulsification as in the case of liquid pairs of unequal sp. gr. H. H. HO.

450. Factors governing the stability of oil-in-water emulsions. A. KING. *Trans. Faraday Soc.*, **37**, *pp.* 168–180, *March*, 1941.—The strength and compactness of the interfacial film is the most important single factor favouring stability; and there is little to distinguish between the stability of the film and of the emulsion. The stability of an emulsion of moderately high oil concentration is not seriously affected by the addition of electrolytes except when the amount of agent is insufficient to form a coherent film round the oil globule. The lower the concentration of the emulsifying agent, the weaker is its protective action and the more do the properties of the emulsion resemble those of a lyophobic colloid. The typical stabilized emulsion of the oil-in-water type possesses hydrophilic properties, especially with excess of emulsifying agent, and may be regarded as a combination of and intermediate between a hydrophilic and a hydrophobic colloid. This picture of the stabilized emulsion is very similar to that of a protected colloid. H. H. HO.

451. Stabilization of water-in-oil emulsions by oil-soluble soaps. R. C. PINK. *Trans. Faraday Soc.*, **37**, *pp.* 180–184, *March*, 1941.—The effect of water on benzene solutions of a number of polyvalent metal soaps has been examined. Oil soluble soaps which are precipitated from solution when shaken with water give rise to stable water-in-oil emulsions provided the precipitated soap fulfils the following conditions : (*i*) It must be insoluble in both phases ; (*ii*) it must remain at the interface, i.e. it must be partially wetted by both liquids ; (*iii*) there must be sufficient lateral adhesion between the solid particles. Stable water-in-benzene emulsions are obtained with Mg oleate, Mg stearate and Ni stearate but not with the oleates of Ca, Ba, Sr, Zn or Ni. AUTHOR.

452. Effect of *p*H upon the electrophoretic mobility of emulsions of certain hydrocarbons and aliphatic halides. W. DICKINSON. *Trans. Faraday Soc.*, **37**, *pp.* 140–148, *March*, 1941.—The effect of the *p*H of the aqueous phase upon the electrophoretic mobility of emulsions of certain hydrocarbons and aliphatic halides, in the presence of 0·01 *N* Na ion, and at 25°C., has been investigated over the range *p*H 2·0 to *p*H 11·8. In each case the emulsions carry a small positive charge in the lowest *p*H values, but as the *p*H is increased the charge is reversed while the *p*H is still small, and on increasing the *p*H still further the negative charge increases and finally attains an almost constant value above *p*H 9. The mobility effects of the various substituent groups are best compared in the alkaline region, where the curves have flattened off and run nearly parallel to each other. The source of the negative charge on the particle is discussed in relation to the effect of *p*H on the charge. The effect of the nature of the end group upon the mobility of emulsions of the appropriate compounds is discussed in the light of the residual charge on the end group. AUTHOR.

453. Electrophoresis of complex particles as a function of *p*H: effect of stearic acid in ester particles. G. GROWNEY. *Trans. Faraday Soc.*, **37**, *pp.* 148–151, *March*, 1941.—The electrophoretic mobilities of droplets of esters containing various amounts of stearic acid have been determined in the presence of 0·01 *N* Na ion over the range *p*H 2 to 12. The mobilities observed for these composite droplets do not lie in an intermediate position with respect to the mobilities of the two constituents by themselves. It is inferred that the orientation of the surface layer of the stearic acid in the composite droplet differs from that which occurs in the case of particles of stearic acid itself. AUTHOR.

454. Anomalies between electrophoretic mobility and interfacial-tension data for paraffin-chain salt solutions. J. POWNEY AND L. J. WOOD. *Trans. Faraday Soc.*, **37**, *pp.* 152–155, *March*, 1941.—Measurements of electrophoretic mobilities of oil drops in paraffin-chain salt solutions are compared with interfacial-tension data for corresponding oil-paraffin-chain salt solution interfaces. Several instances are recorded of high mobilities due to surface-active ions under conditions which give rise to little or no lowering of interfacial tension. AUTHORS.

455. Studies in colloidal clays. II. E. A. HAUSER AND D. S. LE BEAU. *J. Phys. Chem.*, **45**, *pp.* 54–65, *Jan.*, 1941.—The cataphoretic velocity of purified, colloidal, monodisperse fractions of bentonite increases with decreasing particle size. With constant particle size it decreases with increasing concentration, the drop being most pronounced with the smallest particles. In extreme dilutions (up to 0·5%) the cataphoretic velocity remains constant for a given particle size. The sudden drop occurs at a distance between particles of about 5·5 times their apparent diameter. An explanation for this phenomenon is offered. The viscosity in extreme dilutions is independent of particle size. It increases progressively with concentration and particle size. The apparent sp. gr. at low concentrations is smaller than that of dry bentonite ; at high concentrations it is greater. An evaluation of the average distance between the particles in a system which exhibits a yield point substantiates the assumption that far-reaching forces are responsible for the formation of some kind of structure. [See Abstr. 61 (1940).] AUTHORS.

456. Studies in the degree of dispersion of clays. C. E. MARSHALL. *J. Phys. Chem.*, **45**, *pp.* 81–93, *Jan.*, 1941.—The only experimental method giving clear qualitative indications regarding particle shape is the investigation of the dityndallism caused by flow. For the clay minerals montmorillonite, beidellite, illite, kaolinite and halloysite, it is shown that particles larger than 100 mμ are definitely platy and probably have only slight elongation. It is therefore possible to combine sedimentation velocities with ultra-microscopic counts in order to determine the major and minor axes of the plates regarded as flattened ellipsoids of rotation. The orientation of the optical and electrical ellipsoids for all the clays examined is such that the larger axes lie approximately in the plane of the plates. The tilting of clay particles in their flow through circular tubes is discussed in the light of Langmuir's theory of particle interaction. Birefringence of flow for the clays examined is always accompanied by this tilting effect. AUTHOR.

457. Changes in kaolin when gradually heated in the presence of air or other gases. G. F. HÜTTIG AND E. HERRMANN. *Kolloid Zschr.*, **92**, *pp.* 9–35, *July*, 1940. *In German.*—After a survey of previous literature the authors describe the investigations carried out with several samples of kaolin during calcination in the presence of air, N, O, HCl, H_2O, SO_2, NO_2 and .4 $NO_2 + O_2$, for different degrees (between 80° and 800°C.) of preheating. The investigations referred especially to the volatilizing loss, adsorption measurements, solubility of the Al_2O_3 and SiO_2 components, X-ray spectra and the different stages of dehydration and their influence on other physical properties. R. N.

458. Relations between electric conductivity and degree of dispersion of lyophile colloids. I. General remarks. E. Angelescu. **II. Conductivity of sodium and potassium palmitate and stearate solutions in presence of ortho-cresol.** E. Angelescu and A. Woinarosky. *Kolloid Zschr.*, **92,** *pp.* 94–105, *July*, 1940. *In German.*—In Part I the differences between the factors determining the conductivity of common electrolytes and of colloid electrolytes are pointed out. For the latter the number of charged particles is not related to the degree of dissociation. The charge transported by a particle depends on the grouping of molecules, on the number of molecules on the surface of the particle, and—under consideration of the experimental conditions—on the dissociation constant. In the process of dissociation 2 kinds of ions with different speeds are formed, viz. common ions with small charge and high mobility and large colloidal ions with big charge and small mobility. This explains the near relation between conductivity and degree of dispersion. Lyosorption exerts a counteracting influence on conductivity. Degree of dispersion and lyosorption depend on the mutual solubility of colloid and dispersion medium. In Part II experimental results are tabulated and illustrated by graphs showing the change of the specific conductivity of the soap solutions examined, for temperatures between 20° and 60°C., plotted against different concentrations of cresol. The experiments confirm the theoretical considerations. R. N.

✱ **459. Electrodialytic-cataphoretic apparatus for colloid-chemical purposes.** O. Dahl. *Kolloid Zschr.*, **92,** *pp.* 70–75, *July*, 1940. *In German.*—The apparatus consists of 3 parts, viz. a glass cylinder open on both sides, an anode compartment and a cathode compartment, the two latter being built of wood made waterproof by impregnation. The electrodes consist of stainless steel wire netting. The diaphragms placed between glass cylinder and electrode compartments consist of cellophane for the anode and parchment paper for the cathode. The electrode compartments are rinsed with water during the dialysis and thus the electrolytes are washed out. The apparatus serves either for freeing the colloid quickly and thoroughly from electrolytes or for separating the dispersed phase from the dispersion medium. With heterogeneous colloid mixtures a separation of the sol and gel fractions may be attained. As an example the fractional separation of starch paste into amylosis and amylopectin is described and the results are tabulated. R. N.

See also Abstract 490.

CRYSTAL STRUCTURE AND SPECIAL PROPERTIES.

460. Photographic Fourier syntheses. M. L. Huggins. *Commun. No.* 789. *Kodak Res. Lab. J. Amer. Chem. Soc.*, **63,** *pp.* 66–69, *Jan.*, 1941.—The optical method, proposed in 1929 by Bragg, for making Fourier syntheses for use in crystal-structure analysis has been modified to make it more accurate and much faster and to eliminate the overall background density in the resulting photograph. Author.

461. Properties of quaternary alloy equilibrium diagrams. A. J. C. Wilson. *Proc. Camb. Phil. Soc.*, **37,** *pp.* 95–101, *Jan.*, 1941.—These alloys may be represented by a point inside a tetrahedron, the corners of which represent the pure components. This 3-dimensional figure is clumsy to use ; plane sections are more convenient, and the authors deal in this paper with the constraints on the form of these sections. The results are expressed mathematically. G. G.

462. Crystal structure of aluminium black. W. O. Milligan and A. B. Focke. *J. Phys. Chem.*, **45,** *pp.* 107–108, *Jan.*, 1941.

463. Relationships between lattice types and Brillouin zones. G. V. Raynor. *Phil. Mag.*, **31,** *pp.* 131–138, *Feb.*, 1941.—The form of the Brillouin zone for a complex structure may often be determined by referring the appropriate cubic type of lattice to the axes of the structure to be considered and deforming it in a suitable way. In this fashion the Brillouin zones are deduced for body- and face-centred tetragonal structures (from face- and body-centred cubes) ; for the white Sn structure, allowing for planes which do not reflect X-rays ; for the diamond structure ; for In and for Hg. The latter is derived from the deformation of a face-centred cube, which is considered as rhombohedral with $\alpha = 60°$. J. T.

464. Brillouin zone for the Ga structure. G. V. Raynor. *Phil. Mag.*, **31,** *pp.* 139–143, *Feb.*, 1941. —Electrical resistance data, and considerations of the intensity of X-ray reflection, lead to the conclusion that the important Brillouin zone for consideration of the properties of Ga is that bounded by planes of the type{113}, {200}, and {020}. J. T.

465. Crystal structure of iodic acid. M. T. Rogers and L. Helmholz. *J. Amer. Chem. Soc.*, **63,** *pp.* 278–284, *Jan.*, 1941.—The structure of the α-modification of crystalline HIO_3 has been determined. Laue and oscillation photographs show that the orthorhombic unit cell contains 4 molecules of HIO_3. The space group is $D_2^4 - P_{2_1 2_1 2_1}$. Patterson and Fourier projections on the 3 axial planes calculated from visually observed intensity data gave the 12 parameters for the O and I atoms. The structure is an aggregate of HIO_3 molecules held together by H bonds of the bifurcated type and weak I-O bonds. The influence of the different types of bond on the structure is discussed and its relation to the perovskite structure shown. AUTHORS.

DIFFUSION AND OSMOSIS.

466. Cell permeability and diffusion across the oil/water interface. J. F. DANIELLI. *Trans. Faraday Soc.*, **37**, *pp.* 121–124, *March*, 1941.—The cell plasma membrane is, to a first approximation, a thin layer of lipoid (sterols, phosphatides and fats), not more than 10^{-6} cm. in thickness, stabilized by adsorbed protein layers at the two oil/water interfaces. Resistance to the free diffusion operates (*a*) at the membrane interface, diffusion from water→oil; (*b*) at the membrane interface, diffusion oil→water; (*c*) in the interior of the membrane. The author tries 2 sets of assumptions : (1) the interfacial resistances (*a*) and (*b*) are replaced by single potential-energy jumps, and Fick's equation is applied to diffusion in the interior of the membrane ; (2) the interfacial resistances are replaced by single-potential energy jumps and the interior of the membrane is regarded as a succession of potential-energy max. and min. The equations are, however, of very restricted use. H. H. HO.

467. Osmotic and activity coefficients of trivalent chlorides in aqueous solution at 25°C. C. M. MASON. *J. Amer. Chem. Soc.*, **63**, *pp.* 220–223, *Jan.*, 1941.—The osmotic coefficients of $SmCl_3$ and $EuCl_3$ have been determined in aqueous solution at 25°C. by the isotonic method. A new method is described for the smoothing of osmotic coefficients and the calculation of activity coefficients. AUTHOR.

468. Dissolution and diffusion rates in alcohol-water mixtures. E. J. ROEHL, C. V. KING AND S. KIPNESS. *J. Amer. Chem. Soc.*, **63**, *pp.* 284–287, *Jan.*, 1941.—Dissolution rates of Mg and Zn in HCl and of Mg in acetic acid have been measured in mixtures of ethyl alcohol and water. Diffusion coefficients of these acids and of KCl have been measured in the same mixed solvents. The mechanism of the dissolution process is discussed. AUTHORS.

ELASTICITY AND PLASTICITY.

469. Dynamical determination of the elastic constants and their temperature coefficients for quartz. J. V. ATANASOFF AND P. J. HART. *Phys. Rev.*, **59**, *pp.* 85–96, *Jan.* 1, 1941.—A mathematical theory is presented giving the relations between the elastic constants and the frequencies of piezoelectric vibration for an infinite plate of homogeneous but aeolotropic material. The viewpoint of perturbation theory indicates that certain frequencies of vibration of finite plates asymptotically approach the frequencies of vibration of infinite plates of the same material, orientation and thickness, as the harmonic order increases. The experimental results confirm that this is a good method of eliminating edge effects, and accurate data independent of mother crystal and proportions of the plate are obtained. However, in the evaluation of the elastic constants and their temperature coefficients from these data a discrepancy is found between the results and the classical elastic theory for substances of the symmetry class D_3 generally accepted for quartz. Detailed observations have been made in the temperature interval from 0° to 80°C., but additional results make possible the calculation of values of certain elastic constants at higher temperatures up to the α-β transition point. AUTHORS.

470. Determination of the c_{44} elastic constant for β-quartz. J. V. ATANASOFF AND E. KAMMER. *Phys. Rev.*, **59**, *pp.* 97–99, *Jan.* 1, 1941.—A careful determination of the elastic constant c_{44} of β-quartz has been made using the method of Atanasoff and Hart. The result obtained, $c_{44} = 35{\cdot}75 \times 10^{10}$ dynes/cm.^{2}, differs by a factor of nearly 2 from the only other published value. A study of this constant in the range 0° to 650°C., the consistency in the value obtained from different cuts from different crystals, and other facts, seem to justify the value given. AUTHORS.

471. Elasticity problems when second-order terms of the strain are taken into account. Z. SAKADI. *Proc. Phys.-Math. Soc., Japan*, **22**, *pp.* 999–1009, *Dec.*, 1940.

***472. Measurement of tension in liquids by means of metal bellows.** R. S. VINCENT. *Proc. Phys. Soc., Lond.*, **53**, *pp.* 126–140, *March*, 1941.—The paper commences with an historical review of published work. A form of apparatus is then described in which a metal bellows, closed by a needle valve, contains the liquid under test, and the possibility of inward leakage of atmospheric air is avoided by completely surrounding the bellows and valve by the same liquid. A gradually increasing tensile load is applied to the bellows until the liquid breaks. The hydrostatic tension which existed in the liquid immediately prior to breaking is then calculated from the load and the known effective cross-section of the bellows. The liquids so far examined by this method are ethyl alcohol, ethyl ether and mineral oil. The scope of the paper has been confined to results obtained in the temperature range 0° to 30°C. AUTHOR.

*473. **Apparatus for measuring the lateral pressure of clay samples under a vertical load.** G. M. BINNIE AND J. A. PRICE. *J. Instn Civ. Engrs*, **15**, *pp*. 297–306, *Feb*., 1941.—The true measurement of lateral pressure of clay requires that the lateral measurement should be negligible. The apparatus described requires movement of less than 0·001 in. It comprises a cylinder taking a plug of the clay on test, 4 in. dia., and a piston is applied laterally, the movement of which is applied to a shaft to vary the friction, the latter being read by rotation of a scale arm and weights. Calibration is performed by means of a water pressure gauge. Some test results are given, but the work is incomplete.

E. H. W. B.

GRAVITATION.

474. **Determination of the Earth's gravitational field.** H. JEFFREYS. *Mon. Not. Roy. Astr. Soc. Geophys. Suppl*., **5**, 1, *pp*. 1–22, 1941.—The estimation of the Earth's ellipticity from observations of gravity is much complicated by the fact that the residuals against any formula including only low harmonics are far from independent. The existing observations have been treated by forming summaries of the free-air anomalies over 10° squares and reducing to the mean height of the square, so as to eliminate the correlation of the free-air anomaly with height. There is a variation of the means so reduced amounting to about 22 mgals in mean square, in addition to the sampling error, and this must be taken into account. The results for 10° squares are combined to give estimates for the contributions from the low harmonics over 30° squares, and hence to estimate the harmonics up to order 4. There is good evidence that some harmonics other than the main ellipticity term are present, but the data are not adequate to separate them, mostly on account of the lack of data for the S. Pacific and high southern latitudes. There are signs that more of the variation is due to harmonics of degree about 6. An estimate is found for the ellipticity term, which agrees well with the international formula and with the astronomical estimate, but its standard error is over twice that found by Heiskanen, mostly on account of the allowance for the correlation between residuals within the same 10° square.

AUTHOR.

HYDRODYNAMICS AND AERODYNAMICS.

475. **Wind tunnel correction for a circular open jet tunnel with a reflection plate.** B. DAVISON AND L. ROSENHEAD. *Proc. Roy. Soc. A*, **177**, *pp*. 366–382, *Feb*. 24, 1941.—It is advantageous to make test models as large as possible. One method of doing this is to measure the characteristics of ½ the model in existing wind tunnels. One half of the aerofoil is mounted horizontally on a vertical reflection plate and the plate is placed in a suitable position in an open jet which, in the undisturbed state, is of circular section. The contour of the jet is distorted, especially with models of large semi-span, but this distortion is neglected in the analysis. The correcting factor associated with uniform distribution of lift is worked out exactly and that associated with elliptic distribution approximately. The effect of the induced downwash on the distribution of lift is ignored. The results are given in suitable tables and figures. Throughout the working range of normal experiments the correcting factor is of the same order of magnitude as that obtaining when a full model is tested in a jet of circular section. AUTHORS.

476. **Forces on a plane aerofoil in a wind tunnel of the Göttingen type, with special reference to an approximate formula for the lift.** S. TOMOTIKA AND H. UMEMOTO. *Rep. Aero. Res. Inst. Tokyo, No*. 185, *pp*. 473–558, *Nov*., 1939. *Coll. Pap. Fac. Sci., Osaka Imp. Univ. B*, **7**, 1939.—Exact expressions for the forces acting on a plane aerofoil of definite width, placed in a 2-dimensional jet of an incompressible perfect fluid, and for the lift, are obtained. In the special case, when the mid-point of the plane aerofoil lies on the central line of the jet at infinity upstream, the forces are calculated for angles of attack of 5°, 10°, and 15°. The interference effect of the bounding free surfaces of the jet on the lift of the aerofoil is discussed in detail. The lift is decreased owing to this effect, irrespective of the angle of attack. An approximate formula for the lift is deduced, and this has been tested on experimental models. A. J. M.

477. **Turbulence and energy dissipation.** A. A. KALINSKE. *Trans. Amer. Soc. Mech. Engrs*, **63**, *pp*. 41–48, *Jan*., 1941.—This paper incorporates a study of the origin and dissipation of turbulence energy which makes possible a better understanding of the mechanics of energy losses that are introduced by various flow-disturbing devices such as expansions, bends, valves, etc. The important parameters which characterize turbulence are the r.m.s. values of the fluctuating velocity components, the length factor proportional to the size of the small eddies responsible for the dissipation of energy, and the length factor proportional to the average size of the eddies. The effect of variation of these parameters on the energy losses occurring in turbulent flow are discussed, and the change in these parameters in the decaying turbulence beyond turbulence-producing devices is indicated. Data are presented showing the variation in the kinetic energy of mean flow and the turbulence

energy in a 15° conical divergence. Visual studies of the start of turbulence at rounded entrances to smooth conduits seem to indicate that there is a regular vortex formation at the boundary, and the dispersion of these vortexes into the main fluid stream gradually establishes normal turbulent flow. AUTHOR.

478. Behaviour of liquid conductors in magnetic fields. (Electric determination of flow velocities.) B. THÜRLEMANN AND F. DESSAUER. *Helv. Phys. Acta*, **13,** 5, *pp.* 343–345, 1940.—A method is developed for measuring the velocity of flow by observing the p.d. induced in a magnetic field. Turbulence and the variation of the velocity over the cross-section do not interfere with this method. R. P.

479. Flow of muds, sludges and suspensions in circular pipe. D. H. CALDWELL AND H. E. BABBITT. *Industr. Engng Chem.*, **33,** *pp.* 249–256, *Feb.*, 1941.—It was found that 2 distinct types of flow occurred, depending upon the velocity of flow. These two types have been termed plastic flow and turbulent flow. The velocity at which plastic flow changes to turbulent flow is the critical velocity. Equations are developed and verified experimentally for determining friction losses for plastio flow and for turbulent flow in a circular pipe. An equation for the determination of the critical velocity is also presented, together with experimental verification. Methods of determining the significant constants in the plastic flow and critical velocity equations are described. AUTHORS.

∗480. Electrical transmission of flow and level records. A. LINFORD. *Beama J.*, **47,** *pp.* 97–101, *Dec.*, 1940 *and* **48,** *pp.* 15–16, *Jan.*, 1941. [Abstr. 364B (1941).]

MECHANICS, QUANTUM.

481. Stability and magnitude of electronic charges. II. Scalar wave functions. A. LANDÉ AND L. H. THOMAS. *J. Franklin Inst.*, **231,** *pp.* 63–70, *Jan.*, 1941.—Continuing the work of Landé [Abstr. 2333 (1940)] on particles characterized by a fundamental momentum and a fundamental length, the scalar wave functions for such particles are obtained. Use is made of the Einstein relation connecting mass and energy, of the signal equation and of the Schrödinger-Klein-Gordon equation for a free particle. G. C. McV.

482. Interaction of mesons with radiation fields. M. KOBAYASI AND R. UTIYAMA. *Proc. Phys.-Math. Soc. Japan*, **22,** *pp.* 882–898, *Nov.*, 1940. —The transition probabilities of processes caused by the interaction between vector mesons and radiation fields have been investigated. The transition probabilities of 2 elementary processes, the scattering of a photon by a meson and the creation of a pair of positively and negatively charged mesons by 2 photons, are considered. The cross-sections for the "Bremsstrahlung" of mesons and the creation of meson pairs by γ-rays in the static field of a nucleus have been calculated by the method of impact parameters. The cross-sections for the radiative processes of mesons increase very rapidly with increasing energy of the incident mesons or photons. The validity of the theory is discussed. A. J. M.

See also Abstract 439.

PRESSURE.

∗483. Large molecular pumps of the disc type. S. v. FRIESEN. *Rev. Sci. Instrum.*, **11,** *pp.* 362–364, *Nov.*, 1940.—Describes a molecular pump of high capacity which is in some respects similar to that made by Siegbahn in which a disc rotates at high velocity inside a narrow drum in the walls of which is cut a tapered spiral. In the present pump the disc has a diameter of 54 cm. and there are 3 spirals, thus making, in effect, 3 pumps in parallel. The grooves in the spiral are 22 mm. wide, their depth varying from 22 to 1 mm. At a speed of rotation of 3 700 r.p.m. the pumping speed is 73 l./sec. and the ultimate vacuum, as measured on an ionization gauge, is $6\cdot10^{-7}$ mm. Hg. G. E. B.

RELATIVITY AND ETHER.

484. Asymmetrical metric in the 4-space of general relativity. G. RANDERS. *Phys. Rev.*, **59,** *pp.* 195–199, *Jan.* 15, 1941.—Physical space-time allows of a metric of asymmetrical properties because of the uni-direction of time. The simplest possible asymmetrical generalization of Riemannian metric is considered. The study of this metric is mainly confined to the mathematical aspects. However, the physical consequences by application to space-time are obvious and may lead to a description of the electromagnetic field. A close formal connection with 5-dimensional Riemannian geometry is shown. AUTHOR.

See also Abstract 531.

SOLUTION.

485. Alpha solid solutions of the Zn-Ag system. II. H. LIPSON, N. J. PETCH AND D. STOCKDALE. *J. Inst. Met.*, **67,** *pp.* 79–85, *Feb.*, 1941. [Abstr. 317B (1941).]

See also Abstracts 457, 468.

SURFACE PROPERTIES.

486. Determination of surface areas. P. H. EMMETT AND T. DE WITT. *Industr. Engng Chem.*

(*Analytical Edition*), **13,** *pp.* 28–33, *Jan.* 15, 1941.—A method for the determination of surface areas involving low-temperature adsorption has been examined in connection with a series of pigments, carbon blacks, zinc oxide, titanium dioxide, barium sulphate, zirconium silicate, graphite, cement, lithopone, paper and cuprene. The surface areas are obtained by selecting on each experimental adsorption isotherm of some gas, such as N_2, the point corresponding to a monolayer. By multiplying the number of molecules required to form such a layer by the area occupied by each adsorbed molecule the absolute area of a given weight of adsorbent is obtained. A. J. M.

487. Base exchange of the clay mineral montmorillonite for organic cations and its dependence upon adsorption due to van der Waals forces. S. B. Hendricks. *J. Phys. Chem.*, **45,** *pp.* 65–81, *Jan.*, 1941.—A number of organic salts of the clay mineral montmorillonite were prepared and values of their interplanar cleavage spacings, *d*(001), were measured at various organic cation contents. Results show that the organic cation is held to the surface of the silicate layers not only by Coulomb forces but also by van der Waals attraction of the molecules to the surface. Values of *d*(001) depend upon the structure of the organic cation and the manner in which it is adsorbed. This dependance is elaborated into a method for the determination of molecular thickness for van der Waals adsorption. Author.

488. Relationships between the adsorption isotherm and the spreading force. W. B. Innes and H. H. Rowley. *J. Phys. Chem.*, **45,** *pp.* 158–165, *Jan.*, 1941.—A thermodynamic relationship between spreading force and the data of the adsorption isotherm has been derived by considering 2 reversible processes whereby the surface film could be formed. The application of this relationship has been compared with the method of Palmer for calculating spreading force from adsorption data. A 2-dimensional equation of state corresponding to the Langmuir adsorption isotherm has been derived which is similar to that which would be expected for a real 2-dimensional gas. A perfect 2-dimensional gas was found to correspond to a linear adsorption isotherm. Authors.

489. Heat of adsorption of water by papers. C. C. Houtz and D. A. McLean. *J. Phys. Chem.*, **45,** *pp.* 111–127, *Jan.*, 1941.—It is found that stabilization of the moisture adsorption characteristics of 2 types of cellulosic tissue, one of linen derivation and the other of kraft wood pulp, in the temperature range from 100° to 150°C. and for equilibrium relative vapour pressures from 0 to 25 mm. of mercury, can be accomplished by heating the papers in the dry state for more than 40 and 120 hr., respectively, at 150°C. Increased time of heating in the dry state decreases the adsorption of water vapour toward a min. The decrease in adsorption resulting from the stabilization treatment is unaffected by time within the temperature and pressure limits encountered in measuring a series of isotherms. The percentage decrease in adsorption for both papers is practically constant for all temperatures at vapour pressures of water above 10 mm. At low vapour pressures the percentage decrease is irregular. Authors.

490. Internal surface of cellulosic materials, A. J. Stamm and M. A. Millett. *J. Phys. Chem.*, **45,** *pp.* 43–54, *Jan.*, 1941.—Values for the internal surface of cellulosic materials have been calculated from adsorption data for gases and vapours, from data on selective adsorption from solution, from data on heats of swelling and on adhesion tension taken from the literature, and from new data on selective adsorption. These values fall into 2 groups. Systems in which the cell wall is not swollen give surfaces of about 2×10^3 cm.^{2}/g., whereas systems in which the cell walls are swollen give surfaces of about 3×10^6 cm.^{2}/g. The former are shown to measure only the microscopically visible surface, whereas the latter measure the surface of the transient capillary structure created within the cell walls by the swelling agents. Authors.

491. Surface energy and surface entropy. A. Ferguson and E. J. Irons. *Proc. Phys. Soc., Lond.*, **53,** *pp.* 182–185, *March*, 1941.—It is shown that total molar surface energy (ΔE) and molar surface entropy (ΔS), when defined by the equations $\Delta E=\mu-T\partial\gamma/\partial T$, and $\Delta S=-\partial\mu/\partial T$, where μ is free molar surface energy, are constants independent of temperature and are connected by the relation $T_c\cdot\Delta S=\Delta E$, where T_c is the critical temperature. Further, ΔE, defined in this way, is identified with E_0, the zero value of the molar surface energy of the supercooled liquid, when molar surface energy is defined in the usual manner. Authors.

492. Change with time of surface tension of sodium laurate solutions. G. C. Nutting and F. A. Long. *J. Amer. Chem. Soc.*, **63,** *pp.* 84–88, *Jan.*, 1941.—The fall with time of the surface tension of aqueous solutions of sodium laurate has been measured by the method of sessile bubbles at 25°C. At *p*H 11 and concentrations less than the critical concentrations for micelle formation the surface tension falls gradually for several hrs. The equilibrium surface tension depends upon the concentration. The time effect largely disappears in micellar solutions. With decreasing *p*H the equilibrium surface tension and the time required to attain it diminish markedly. This result is thought to be due to the possibility of closer packing of fatty-acid molecules than ions in the surface film and the more rapid diffusion of non-ionized molecules into the surface region. AUTHORS.

493. Surface tension of solutions of electrolytes as a function of the concentration. II. G. JONES AND W. A. RAY. *J. Amer. Chem. Soc.*, **63,** *pp.* 288–294, *Jan.*, 1941.—The relative surface tensions of aqueous solutions of $BaCl_2$, $LaCl_3$, $KClO_3$, KCNS, $K_3Fe(CN)_6$, $K_4Fe(CN)_6$, CsJ and LiF, have been measured over a wide range of concentration at 25°C. It is shown that these 8 salts, like the 3 others previously studied [Abstr. 1074 (1937)], all cause a decrease in surface tension at extreme dilution and must be positively adsorbed from very dilute solutions. It seems probable that all salts are capillary-active in sufficiently dilute solutions. At moderate and high concentrations these salts all increase the surface tension and act like typical capillary-inactive salts. The validity of the Onsager-Samaras and of the Dole equations for the variation of the surface tension with the concentration is discussed. AUTHORS.

494. Physics of upward drilling. F. W. PRESTON AND J. C. TURNBULL. *Amer. J. Sci.*, **239,** *pp.* 92–105, *Feb.*, 1941.—A theory of upward drilling by gas-bearing solutions through a ceiling of a solid phase is developed on the basis of experiments with ice as the solid phase and various fluids and solutions as the liquid phase. It is shown that the composition of the gas phase is unimportant. According to this theory there is one particular size of bubble that is most active, and hence one particular size of cavity that tends to progress most rapidly, with a particular set of components. The size is calculated for ice attacked by alcohol, refractories by molten glass, and for rocks attacked by viscous magmas. It would appear that the order of magnitude is right in each case. AUTHORS.

495. Interfacial activity of branched-paraffin-chain salts. G. S. HARTLEY. *Trans. Faraday Soc.*, **37,** *pp.* 130–133, *March*, 1941.—From a theoretical discussion it is predicted that a salt with double- or branched-chain ions will have rather less interfacial activity, at the same single ion concentration, than a corresponding straight-chain salt, but that, if it is sufficiently soluble, the former will continue to reduce interfacial tension with increasing concentration beyond the concentration at which reduction by the latter ceases. Adequate single-ion solubility should be assured by the more awkward shape of the ions, leading to a weaker crystal structure. These predictions have been verified by experiments with compounds prepared by sulphonation of di-alkyl ethers of dihydric phenols. H. H. HO.

496. Interfacial tension, viscosity and potential changes, produced by insoluble monolayers at the oil/water interface. A. E. ALEXANDER. *Trans. Faraday Soc.*, **37,** *pp.* 117–121, *March*, 1941.—A brief survey is given of the possible methods of measuring changes in the interfacial tension, viscosity and potential, brought about by spreading insoluble monolayers at the O/W interface. The results of such measurements are compared with those obtained with the same or related compounds at the A/W interface. For small values of *F*, i.e. small lowerings of the I.T., the areas at the O/W interface are very much greater than at the A/W, but as *F* increases the two approach until an identical packing is obtained. From the equation of state and the changes in interfacial potential it appears that very considerable information can be obtained about the properties of monolayers at the O/W interface from measurements at the A/W. AUTHOR.

497. Effect of orientation at the oil/water interface of esters and their digestion by pancreatin. J. H. SCHULMAN. *Trans. Faraday Soc.*, **37,** *pp.* 134–139, *March*, 1941.—Direct analogies have been drawn from observations on the adsorption of OH^- ions on the ester molecules orientated at the air/water interface to the adsorption of the OH^- ions at the oil/water interface. These results have been used to explain the curious specific action of the lipoclastic ferment in pancreatin on its digestion of aliphatic esters. The esters varied in the number of carbon atoms attached to the alcohol and acid radical hydrocarbon chains. Further, the action of long-chain hydrocarbon ionic salts was studied on the rate of digestion, by the lipoclastic ferment in pancreatin, of a long-chain ester. AUTHOR.

*498. **State of monolayers adsorbed at the interface solid/aqueous-solution.** F. M. FOWKES AND W. D. HARKINS. *J. Amer. Chem. Soc.*, **62,** *pp.* 3377–3386, *Dec.*, 1940.—An improved apparatus has been developed for the determination of the contact angle between a liquid and the plane surface of a solid by the tilting plate. A theory is given by which it is possible to determine the film pressure at the interface between a solid and an aqueous solution of an organic substance when the contact angle is >0. The assumption is made that the free surface energy of the solid/liquid interface, already greatly lowered by the adsorption of water vapour, is not sufficiently affected by the additional adsorption of the organic substance to alter the contact angle materially, and an experimental test of this assumption is described. Interfaces fall into 2 classes : (*i*) Vapour/liquid, and paraffin/liquid, and (*ii*) stibnite/liquid, talc/liquid, and graphite/liquid, and at a given activity or a given film pressure the molecular areas in films of butyl alcohol are much smaller for (*ii*) than for (*i*). The pressure/area relations and the wetting characteristics of films of adsorbed organic molecules depend on the type of polar group in the molecules. H. H. Ho.

499. States of monolayers. W. D. Harkins and E. Boyd. *J. Phys. Chem.*, **45**, *pp.* 20–43, *Jan.*, 1941.—The general phase relations of monolayers on a liquid sub-phase are examined. There is evidence for the existence of at least 2, and possibly 3, phases which show the viscosity relations attributed in 3 dimensions to the liquid state. The first-order transition from a low-pressure vapour film to either a solid, a condensed liquid, or an intermediate liquid film, is considered. The relation between molecular dimensions and the phase of a monolayer is discussed. There is at present no sufficient evidence that the areas at which monolayer phase changes occur show any exact correspondence with areas in the various 3-dimensional forms of the crystals of the same substance. The thermodynamic relations of 2-dimensional phases, and the transitions between them, are discussed in the case of pentadecyclic acid. The compressibility of monolayers is considered, and it is shown that each type of phase has its own general order of compressibility. Various theories of the intermediate and expanded liquid states are discussed. A. J. M.

500. Effect of salts on soluble ionized monolayers. A. B. D. Cassie and R. C. Palmer. *Trans. Faraday Soc.*, **37**, *pp.* 156–168, *March*, 1941.—A theory has been developed for the distribution of ions under an ionized monolayer. It explains the fact that only ions of opposite sign to the film have an appreciable effect on the film and agrees quantitatively with available data on the effect of added electrolytes on the surface and interfacial properties of these films. It can be used as a guide to the form of the surface equation of state of ionized monolayers. The air/water potential given by a monolayer and the formation of micelles of long-chain ions in the presence of salts are discussed in the light of the theory. The theory provides a new method of calculating the work of adsorption of long-chain molecules. Authors.

501. Monomolecular films of saccharase. H. Sobotka and E. Bloch. *J. Phys. Chem.*, **45**, *pp.* 9–19, *Jan.*, 1941.—Methods are described for the measurement of film thickness by means of min. reflection of monochromatic light. Procedures are given and discussed for the measurement of film areas and for the micro-determination of saccharase activity of films containing a fraction of 1 μg. of saccharase. Under a variety of conditions saccharase films were thus found more or less soluble and, at the same time, endowed with enzymatic activity from high values down to zero. Because of the solubility of all active films observed it is impossible to decide whether the enzyme may possess any appreciable hydrolytic activity in the deposited state. Built-up saccharase films of a thickness up to 45 Å retain the full enzymatic activity of the material from which the film was formed. Authors.

502. Compressed films at solid/liquid interfaces. J. L. Culbertson and L. L. Winter. *J. Amer. Chem. Soc.*, **63**, *pp.* 95–97, *Jan.*, 1941.—By calorimetric method determinations have been made of the unfrozen water on the surface of wetted silica gel and carbon at temperatures from 0° to − 50°C. Basing a comparison on unit quantities of the solids, the silica binds the water more strongly than the carbon. Authors.

See also Abstracts 448, 449, 454, 457.

VISCOSITY AND FRICTION.

∗503. Experiments on thixotropic and other anomalous fluids with a new rotation viscometer. J. Pryce-Jones. *J. Sci. Instrum.*, **18**, *pp.* 39–48, *March*, 1941.—A description is given of a new viscometer based, in principle, on the rotation of 2 identical Couette viscometers in opposite directions, also of its application to the study of anomalous viscosity, thixotropy, dilatancy, elastic recoil, yield value and the degree of dispersion of suspensions of solids in liquids. In addition a critical review is included of the precise meaning of rheological terms in so far as they can be illustrated by means of the new apparatus. Author.

ASTRONOMY AND ASTROPHYSICS.

ASTRONOMICAL APPARATUS AND OBSERVATORY EQUIPMENT.

∗504. Optical instruments, particularly large astronomical telescopes. G. E. Manville. *Trans. N.-E. Cst Instn Engrs Shipb.*, **57**, [16 *pp.*], 1940–1941.—The author discusses the engineering aspect of the production of optical components. The methods and machines used for grinding and polishing glass are described, and the interim and final testing of the surfaces by spherometer, test plate and test flats, and by the Foucault and Hartmann methods, are discussed. The various forms of mounting of large telescopes are compared, and special attention is given to the 74 in. reflector at the Radcliffe Observatory, Pretoria.

A. Hu.

***505. Hindle-type grinding machine.** C. G. Wates. *J. Roy. Astr. Soc. Can.*, **35**, *pp.* 33–38, *Jan.*, 1941.—The author describes an alligator-type motor-driven machine for grinding mirrors. The machine is cheaply constructed of angle-iron, old automobile gearing and home-made plain bearings, and is suitable for amateur use where saving of labour is a consideration. The processes of coarse and fine grinding and of polishing (also done by the machine) are outlined : the first of these is slower, but the last much faster, than by hand. The main advantage claimed is the uniformity with which any desired irregular stroke can be maintained. A. Hu.

506. Results with the coudé spectrograph of the Mt. Wilson Observatory. W. S. Adams. *Contr. Mt. Wilson Obs. No.* 638. *Astrophys. J.*, **93**, *pp.* 11–23, *Jan.*, 1941.—The development of the coudé spectrograph in use with the 100 in. telescope is traced through its successive stages to its present form. At present 3 Schmidt cameras with focal lengths of 32, 73 and 114 in., respectively, may be used in conjunction with a concave off-axis collimating mirror and a Wood aluminium plane grating on pyrex-glass. The grating has great concentration of light in the red of the first order and the ultra-violet of the second. Illustrations of the application of the spectrograph consist of 5 investigations. The first is a determination of the solar parallax from 37 spectrograms of α Boötis ; 7 spectrograms of Mars in the region about λ 7000 have been used in a study of the water-vapour lines. A high-dispersion spectrogram of *o* Ceti taken about 1 month after max. of light provides evidence that the multiple structure of at least some of the emission lines of H is due to superimposed absorption lines of other elements. The doubling of a considerable number of lines in the spectra of supergiant M-type stars was discovered with the coudé spectrograph. The separation and the relative intensities of the 2 components vary greatly in different stars. All the double lines arise from near the ground state of the neutral or ionized atom, and the amount of widening of other lines appears to depend upon their excitation levels. The position of the mean of the 2 components agrees well with that of the normal line, but the effect can hardly be ascribed to reversal and is probably due to Doppler shifts in the extensive atmospheres of these stars. The original discovery of several sharp interstellar lines in the ultra-violet and violet spectra of some stars of early type has been supplemented by recent observations of the bright star ζ Ophiuchi with higher dispersion. A number of additional lines have been found ; and the presence of several lines of CH, predicted by McKellar, has been established. The existence of molecules of CH in interstellar space seems certain. Author.

NEBULAE.

507. Region of bright nebulosity in the Coal Sack. E. M. Lindsay. *Proc. Roy. Irish Acad. A*, **46**, *pp.* 123–128, *Jan.*, 1941.—The bright nebulosity produced in part of the Coal Sack dark nebula by illumination from a normal *d*G1 or *d*G2 star lying in front of the cloud is examined in detail on Harvard plates. From an assumed absolute magnitude for the illuminating star and its observed apparent magnitude a distance of 166 parsecs is derived for the bright nebula. An analysis of star counts in this region and in neighbouring comparison regions gives a distance of 180 psc. or 160 psc. according to the value assumed for the absorption coefficient in the direction of the nebula. A. Hu.

508. Physical processes in gaseous nebulae. XI. Strengths of forbidden lines in p^2, p^3, and p^4 as a function of coupling. G. H. Shortley, L. H. Aller, J. G. Baker and D. H. Menzel. *Astrophys. J.*, **93**, *pp.* 178–194, *Jan.*, 1941.—[See Abstr. 61 (1941).] The coupling of configurations p^2, p^3 and p^4 is determined by a single parameter χ which ranges from 0 for *LS* to ∞ for *jj* coupling. This paper contains a tabulation of the magnetic dipole strengths and the coefficient of the radial integral in the electricquadrupole strengths for all the forbidden lines in these configurations for all values of χ. The transformation coefficients which express the actual eigenfunctions in terms of the *LS*-coupling eigenfunctions are also tabulated.

Authors.

PLANETS.

509. Figures of the Earth and Moon. H. Jeffreys. *Mon. Not. Roy. Astr. Soc.*, **101**, 1, *pp.* 34–36, 1941.—The author combines 6 data relevant to the ellipticities of the Earth and Moon, viz. the secular motion of the node due to the figures of the bodies, that of the perigee due to the same cause, the monthly term in the Moon's latitude, the inclination of the lunar axis, the annual libration in longitude and an estimate of the main ellipticity term in gravity made from a new discussion of observations over the Earth's surface. The results are in satisfactory accordance. A. Hu.

510. Victoria observations of the transit of Mercury, 1940, November 11. K. O. Wright. *J. Roy. Astr. Soc. Can.*, **35**, *pp.* 1–5, *Jan.*, 1941.—

V.
19

At 5 stations in Victoria, B.C., 13 astronomers observed the transit, using 9 telescopes and observing usually by projection on to a white card, though in some cases direct observation was employed. Second contact was timed by each observer against rated chronometers or watches ; the times observed show a range of about ½ min., which is believed reasonable, considering the poor seeing. A. Hu.

511. The 1940 transit of Mercury. H. B. Brydon and R. M. Petrie. *J. Roy. Astr. Soc. Can.*, **35,** *pp.* 6–14, *Jan.*, 1941.—Visual and photographic observations were carried out at Oak Bay Observatory, Victoria, B.C., on a 4 in. refractor. Two observers watched a 17 cm. projected image of the sun and estimated the time of second contact against a rated chronometer. The telescope aperture was then reduced to 2 in. and 5 plates of the transit secured over an interval of 1 hr. Extrapolating back from these photographs, the authors find the time of second contact with a probable error of 1 min. of time. They consider that under more favourable conditions in the future, using more photographs closer to the time of contact, this probable error could be reduced to a few secs. The experience gained is condensed into a series of recommendations for future work. A. Hu.

STARS.

512. Systematic corrections to the proper motions of the General Catalogue. W. M. Smart. *Mon. Not. Roy. Astr. Soc.*, **101,** 1, *pp.* 37–42, 1941.—A comprehensive discussion of the proper motions of the G.C. requires a knowledge of the systematic errors introduced by small errors in Newcomb's precession and in the equinox and by failure to apply the rotational corrections. The author derives, in literal form and in both equatorial and galactic co-ordinates, the conditional equations for obtaining the solar motion, the precessional corrections and the rotational constants, from the components of proper motion. Numerical tables are given for the centennial corrections to the components, in R.A. and in dec., of the G.C. proper motions. A. Hu.

513. Interpretation of stellar motions in terms of a non-steady-state model for the galaxy. J. Titus. *Astrophys. J.*, **93,** *pp.* 57–63, *Jan.*, 1941.—In the theory of stellar systems in non-steady states a deviation of the vertex of star streaming from the galactic centre is predicted for a model consisting of a central mass and a flattened homogeneous spheroid. In this paper a comparison of this model with our galactic system is made. The constants required to give the motions at points within the galaxy are determined from the 5 observed quantities in the neighbourhood of the Sun, namely the deviation of the vertex, the ratio of the axes of the velocity ellipse, the longitude of the node of the double harmonic wave in the radial velocities, the *K*-term proportional to the distance, and Oort's constant *A*. From these the motion of the local centroid at the Sun is computed and compared with the observed value. The curves for radial velocity to be expected on this model are also illustrated. Author.

514. Interstellar absorption near the north pole of rotation. P. C. Keenan and H. W. Babcock. *Astrophys. J.*, **93,** *pp.* 64–69, *Jan.*, 1941.—Revised spectral classes for B8-A5 stars north of +80° dec. confirm essentially the variation of interstellar absorption with distance found by Stebbins, Huffer and Whitford [Abstr. 3943 (1939)] for these stars. The total visual absorption, which is inappreciable for distances less than 200 parsecs, increases to 0·3 mag. at 400 parsecs. Authors.

515. Diffuse radiation in the galaxy. L. G. Henyey and J. L. Greenstein. *Astrophys. J.*, **93,** *pp.* 70–83, *Jan.*, 1941.—A Fabry photometer, attached to the 40 in. refractor at the Yerkes Observatory, was used to measure the brightness of regions over a wide range of galactic latitude. The intensities in the photographic region of the spectrum were calibrated by means of the Polar Sequence stars. It is shown that the observed intensity of diffuse light may be explained as scattered stellar radiation if the phase function governing the scattering of starlight by the interstellar matter is strongly forward-throwing. The concentration of the diffuse light toward the galactic circle is also in agreement with this property of the phase function. The observations also indicate that the scattering efficiency, or albedo, of the particles is greater than 0·3. Authors.

516. Continuous spectrum of stellar atmospheres consisting only of atoms and negative ions of H. R. Wildt. *Astrophys. J.*, **93,** *pp.* 47–51, *Jan.*, 1941.—Theoretical colour temperatures have been derived for stellar atmospheres, consisting only of H and H^- in ionization equilibrium, over the range of effective temperatures $5040/T_e=0{\cdot}5\text{–}1{\cdot}2$ and for different electron pressures. Choosing the electron pressure so as to reproduce the value of the Balmer discontinuity observed by Barbier and Chalonge [Abstr. 1450 (1940)], the colour temperatures of the spectral types A0-F0 determined by the same authors can be tolerably well represented by the $H\text{–}H^-$ mixture. For the later spectral types the theoretical colour temperatures fall considerably below the corresponding effective temperatures, while the observed colour temperatures are distinctly higher than the effective ones. It does not seem possible to remove this discrepancy by adding the conventional metallic absorption to that of H and H^-. AUTHOR.

517. **Ultra-violet emission lines in spectra of Me variables.** P. W. MERRILL. *Contr. Mt. Wilson Obs. No.* 642. *Astrophys. J.*, **93**, *pp.* 40–46, *Jan.*, 1941.—The lines studied are those between λ 4000 and λ 3700, observed near time of max. light. Marked irregularities in the intensities of lines in the Balmer series are probably due to the abnormal weakness of certain members, notably $H\epsilon$, $H\kappa$, $H\mu$ and $H\xi$. On this assumption the general Balmer decrement does not differ greatly from that of the Be star BD + 11°4 673 or of the H spectrum observed in the laboratory. A few lines of Si II, Fe I and Mg I were observed. $H\iota$ and $H\chi$ exhibit 2 components on a few plates. Most of the lines yield accordant radial velocities, but certain ones are subject to fairly large relative displacements. Peculiarities in intensity, structure and displacement, tend to become less marked after max. light. The absorption of overlying gases provides the best working explanation of the peculiarities. AUTHOR.

518. **Systematic and accidental errors in the spectroscopic absolute magnitudes of dwarf stars of types F, late K, and M.** G. STRÖMBERG. *Contr. Mt. Wilson Obs. No.* 641. *Astrophys. J.*, **93**, *pp.* 33–39, *Jan.*, 1941.—The errors have been determined by the method described previously [Abstr. 2926 (1940)]. The 2 regression lines were determined by grouping the stars on the basis of M_s and $H = m + 5 \log \mu$, respectively, the mean value of M being derived from the trigonometric parallaxes. The 2 regression lines were then used as calibration lines for determining 2 new systems of spectroscopic abs. magnitudes. The first system, M'_s, based on the first regression lines, M on M_s, should be used when the stars are grouped on any basis directly connected with conditions in the stellar atmosphere that determine the spectral features which define M_s for a given spectral interval. The second system, M''_s, should be used when the stars are grouped on any basis directly correlated with the true abs. magnitude or with the energy generation in the interior of the star. AUTHOR.

519. **Determination of mass ratios of spectroscopic binaries.** O. C. WILSON. *Contr. Mt. Wilson Obs. Astrophys. J.*, **93**, *pp.* 29–32, *Jan.*, 1941. —A method is described which permits the determination of the mass ratio and systematic velocity of a double-lined spectroscopic binary from much less observational material than that required for a complete orbit determination. AUTHOR.

520. **Spectrum of β Lyrae.** O. STRUVE. *Astrophys. J.*, **93**, *pp.* 104–117, *Jan.*, 1941.—The system of β Lyrae consists of a normal B9 giant of lower luminosity than β Orionis. Those of its absorption lines which are not associated with emission lines from a nebula change little in intensity outside of eclipse, but those absorption lines which are associated with emission are weak and variable in intensity. The B5 absorption lines come from a nebula which has a condensation 29° after principal min. Dilution effects place the average distance of the nebula at about twice the radius of the B9 star from the latter's surface. The constancy of the normal B9 lines implies that the continuous absorption of the nebula has little effect upon the formation of these lines, and this is interpreted to mean that the nebula is a ring in the equatorial plane of the B9 star, not a complete shell. During principal eclipse the B9 star is eclipsed by a smaller star, so that the lines of the B9 star remain visible. Satellites appear on the red side before central eclipse and on the violet side after central eclipse. These satellites show less dilution than does the B5 spectrum of the ring, and the outflowing stream corresponds to a hotter temperature than the inflowing stream. The violet satellites are interpreted as a stream flowing from the B9 star, along that side of the invisible second component which becomes uncovered after min. light. A part of the stream forms an expanding ring, while another part flows around the invisible component and returns to the B9 star, giving rise to the red satellites. The emission lines show a rotational velocity of more than 300 km./sec., and their changes in structure and intensity agree with the proposed picture of β Lyrae. AUTHOR.

521. **Line intensities in β Lyrae.** J. R. GILL. *Astrophys. J.*, **93**, *pp.* 118–127, *Jan.*, 1941. — Microphotometer tracings have been made from 16 Yerkes spectrograms covering the light-cycle of β Lyrae at various intervals. Profiles of the lines Si II 4 128–4 130, Mg II 4 481, $H\gamma$, $H\delta$, and He I 4 472 are reproduced, and a table of equivalent widths of certain of the B8 (stellar) and B5 (nebular) components is given. It is found that the lines Si II 4 128–4 130 and Mg II 4 481 of the B8 spectrum are not constant throughout the light-cycle but are strongest near primary min. These line intensities of Si II and Mg II must be further qualified, however, since the measured equivalent widths of these lines include the satellites and might, therefore, be found constant throughout the light-cycle if the satellites were subtracted. The B5 components of $H\gamma$, $H\delta$ and He I 4 472 are found to be strongest near primary min. The B8 component of λ4 472 is variable and notably weaker in the first half of the cycle than in the second half. AUTHOR.

522. **Spectrum of β Lyrae in the visual region.** J. L. GREENSTEIN AND T. L. PAGE. *Astrophys. J.*, **93**, *pp.* 128–132, *Jan.*, 1941.—Nine grating spectro-

grams of the visual region of β Lyrae are discussed. In the spectrum of the primary star, of type cB9, the usually strong H and He lines are not clearly seen ; presumably they are weakened by the presence of strong emission lines in the stationary spectrum. The stationary of B5 spectrum consists of strong emission lines of H and He I with strong superposed absorption lines. Na I is present as an absorption line with 2 components ; one component may possibly be interstellar, the other must originate in the nebulous shell. The measured displacements of the B5 absorption lines seem to be independent of the orbital motion of the cB9 star. The absorption is greatest near the phase of primary min. The absorption line He I 5016, originating from a metastable level, is stronger relative to its emission line than are the B5 absorption lines from normal levels. AUTHORS.

523. Nature of the system of β Lyrae. Z. KOPAL. *Astrophys. J.*, **93,** *pp.* 92–103, *Jan.*, 1941.—An analysis of the photometric and spectroscopic evidence available on β Lyrae leads to the following conclusions: (1) The cB9 component is the larger, the more massive, and the more luminous of the two. (2) The mass ratio derived from the ellipticity constant is $m_2/m_1 = 0{\cdot}82$ for a centrally condensed model, and $m_2/m_1 = 0{\cdot}74$ for a polytrope with index $n = 1{\cdot}5$. Irrespective of structure, the masses of the two components do not seem to differ greatly. (3) An approximate interpretation of the rotational effect leads to results that are consistent with the dynamical mass ratio. (4) Two sets of absolute dimensions, corresponding to 2 models of different density condensation, were derived. Except for the masses, there is but little difference between the 2 sets. The min. combined mass of the system results in the value 95 $\odot$, making β Lyrae the most massive eclipsing system known. (5) There is no indication whatever of any motion of the apsidal line in the β Lyrae system. As a high degree of density condensation is at variance with considerations of the H content of the primary component, the orbital eccentricity of $0{\cdot}0137 \pm 0{\cdot}0018$ (p.e.) found by Rossiter appears questionable. AUTHOR.

524. Interpretation of β Lyrae and other close binaries. G. P. KUIPER. *Astrophys. J.*, **93,** *pp.* 133–177, *Jan.*, 1941.—A model for β Lyrae is developed which attempts to account for the complex photometric and spectroscopic phenomena and which is consistent with dynamics. The dimensions of the system are discussed, and the conclusion is reached that the components have a common envelope. It is shown that contact binaries with unequal components are unstable, and that matter streams from *A* to *B* as long as the masses are unequal; that Δm and Δ(spectral type) are abnormally large for the mass ratio; and that a system of currents will be set up. These currents account for the satellite components of spectral lines observed near primary min. If the common envelope attains great height and/or if the currents attain large velocities, ejection of matter from the outer point of *B* will take place. This ejection is considered to supply the source of the mysterious B5 spectrum and to cause the asymmetry and irregularity of the photometric min. Ejection of another type, arising in a separated binary composed of 1 giant and 1 dwarf, is also considered, and its application to peculiar emission stars with composite spectra is stressed. A schematic picture of the gaseous tail in which β Lyrae winds itself is given; the effect is that of a giant pinwheel with 1 streamer. The shadow cast by *B* on the streamer seems to play an important rôle in the spectral features, as it appears to de-ionize the gas. The change of period in β Lyrae is also considered. AUTHOR.

525. Atmospheric structure of ζ Aurigae. F. E. ROACH. *Astrophys. J.*, **93,** *pp.* 1–10, *Jan.*, 1941.—Photo-electric observations of ζ Aurigae made at the Steward Observatory during the ingress of its eclipse in December, 1939, together with those of Kron and of Guthnick and Schneller, are interpreted according to 2 hypotheses; (i) a geometrical eclipse, the partial phase of which lasts $1{\cdot}3$ days, and (ii) the gradual extinction of the B star by the atmosphere of the K star. In order to obtain a temperature for the B star consistent with its spectral class a central eclipse is not possible if the partial phase is due to a geometrical eclipse. The extinction solution gives a good representation of the observations, especially when the points of Kron and of Guthnick and Schneller are corrected to the effective wavelength of the Tucson observations. The consequences of the acceptance of extinction as the mechanism of obscuration are discussed. Colour observations both in and out of eclipse are recorded. AUTHOR.

526. RT Aurigae. A. L. BENNETT. *Astrophys. J.*, **93,** *pp.* 52–56, *Jan.*, 1941.—RT Aurigae was observed during the 2 seasons 1938–40 with the infra-red photometer on the Loomis telescope at an effective wavelength near $\lambda 8000$. The range of variation is $0^{\mathrm{m}}.21$, and min. occurs $0^{\mathrm{P}}.255$ ($0^{\mathrm{d}}.95$) before max. AUTHOR.

527. Visual photometry of variable stars. H. B. BRYDON. *J. Roy. Astr. Soc. Can.*, **34,** *pp.* 409–417, *Nov.*; 444–455, *Dec.*, 1940, *and* **35,** *pp.* 20–32, *Jan.*, 1941.—The author discusses fully the pitfalls met with in the photometry, with the naked eye or telescope, of long-period and irregular variables and novae. Practical methods of comparison are described, and the amateur is warned against various errors due to peculiarities of vision and particularly of colour vision. A. Hu.

528. Photo-electric observations of 12 Lacertae. H. E. Green. *Mon. Not. Roy. Astr. Soc.*, **101**, 1, *pp.* 43–45, 1941.—The variations of this star show a period of 4 h. 38 m. and an irregular amplitude. The paper gives Cambridge observations of the light curve on 20 nights in Sept. and Oct., 1940; these show a marked fluctuation in amplitude and are intended for combination with Lick Observatory results obtained 8 hr. later. The comparison star used was 10 Lac., control observations on 9 Lac. providing a check on the constancy of this star. Atmospheric extinction corrections do not exceed 0·004 mag. A. Hu.

529. Absolute dimensions of a Wolf-Rayet eclipsing binary: HV 11111 = BD + 38° 4010 = HD 193576. S. Gaposchkin. *Astrophys. J.*, **93**, *pp.* 202–207, *Jan.*, 1941.—The Wolf-Rayet star BD+38°4 010 is shown to be an eclipsing binary with the period of $4^{\mathrm{d}}.212\,38$, and with ranges $8^{\mathrm{m}}.39$–$8^{\mathrm{m}}.70$ and $8^{\mathrm{m}}.39$–$8^{\mathrm{m}}.53$. The star has received the Harvard Variable number 11 111. A light-curve has been derived from 1 084 photographic observations made on Harvard patrol plates. The most probable absolute dimensions, taking into consideration the spectroscopic results of Wilson, are: $R_1 = 5{\cdot}8\ \odot$, $R_2 = 0{\cdot}7\ \odot$, $\mu_1 = 10{\cdot}2\ \odot$, $\mu_2 = 25{\cdot}9\ \odot$, $\rho_1 = 0{\cdot}05\ \odot$, $\rho_2 = 0{\cdot}03\ \odot$, $M_{\mathrm{vis}} = -1{\cdot}64$, $M_{\mathrm{vis},2} \doteq -3{\cdot}53$, $i = 80{\cdot}3°$; and the computed gravitational red shift at the surface of the Wolf-Rayet component is only 1 km./sec. An effective temperature is derived in the usual manner from the observed depths of the minima. Author.

530. Spectroscopic binary 29 Canis Majoris. O. Struve and F. Sherman. *Astrophys. J.*, **93**, *pp.* 84–91, *Jan.*, 1941.—A new orbit has been derived from spectrograms taken at the McDonald Observatory. A large difference in the velocity of the centre of mass, as compared with previous observations, may be caused by a third body. The emission lines show a large red shift which is tentatively attributed to self-absorption in an expanding and rotating shell. The structure and intensity of the emission lines undergo large periodic changes. P Cygni type absorption lines are observed on the violet borders of the emission lines between secondary min. of light and primary min. Authors.

SUN.

531. Einstein effect from observations of total solar eclipse on June 19, 1936. T. Matukuma. *Jap. J. Astr. Geophys.*, **18**, 1, *pp.* 51–72, 1940.—The expedition from the Tohoku University obtained during totality one 80 sec. plate on which 8 stars were found to be measurable. After an interval of about 6 months, the field was rephotographed, 2 comparison plates being obtained. Relative displacements were measured in polar coordinates and, after correction for differential refraction, differential aberration and proper motion, were used to form conditional equations involving only the usual plate constants and the Einstein displacement. Least-squares solutions from the eclipse plate and each comparison plate in turn gave $E = 2''{\cdot}13$ and $1''{\cdot}28$ as compared with the theoretical value of $1''{\cdot}74$. The deviations shown by the separate stars indicate that the second of these results is not reliable, but the first gives satisfactorily small residuals. A. Hu.

532. Observational determination of the line absorption coefficient and its variation with depth in the solar atmosphere. H. H. Plaskett. *Mon. Not. Roy. Astr. Soc.*, **101**, 1, *pp.* 3–20, 1941.—The author sets up an observational model, as contrasted with the more usual mathematical model, for solar absorption lines. The theory of this model is developed in a form suitable for numerical calculation without making any simplifying assumptions. An exact form of the equation of transfer is derived, and the corresponding 3 integral equations required for the observational model are formulated. By a division of the solar atmosphere into *n* layers, the solution of 2 of these is reduced to the solution of *n* simultaneous equations, while the third is reduced to a summation of easily found terms. The analysis is then applied to the observed variation of the Mg line λ 5 184 across the solar disc, and the observed values of the line absorption coefficient as a function of depth are derived. The author concludes that, combined with similar work on the continuous spectrum, with improved mathematical methods of analysis and with accurate observations on the continuous spectrum and on absorption lines at the limb, these results should make possible a framework giving observed temperatures and pressures at various depths in the solar atmosphere. A. Hu.

533. Inverse problem of stellar absorption line formation. D. S. Evans. *Mon. Not. Roy. Astr. Soc.*, **101**, 1, *pp.* 21–25, 1941.—The author considers the problem of deducing the characteristics of a stellar atmosphere from observations of the continuous spectrum and of the contour of a Fraunhofer line across the stellar disc. A formal solution is deduced under somewhat restricted conditions. The solution is not adapted to numerical calculation but is shown to be unique. A. Hu.

534. Solution of the equation of radiative transfer. I. W. Busbridge. *Mon. Not. Roy. Astr. Soc.*, **101**, 1, *pp.* 26–33, 1941.—Though the equation of radiative transfer has been numerically solved by trial and error, hitherto no mathematical expression has been found for the temperature distribution with depth which will reproduce observed values of the specific surface intensity of solar radiation within their experimental error. The author reduces the integral equation to the Laplace type ; using observed laws of darkening for various wavelengths a functional form is derived for the specific surface intensity, and the equation is solved. The solution for λ 5 500 is discussed in detail and the results are compared with those already obtained by Plaskett. A. Hu.

535. Nature of solar hydrogen vortices. R. S. Richardson. *Contr. Mt. Wilson Obs. No.* 639. *Astrophys. J.*, **93**, *pp.* 24–28, *Jan.*, 1941.—The H vortices surrounding spot-groups have been explained by the existence of magnetic fields produced by charged particles whirled around the spot at a low level, or as hydrodynamical vortices whose form depends upon how the gases are blowing into or out of the spot. It is possible to test these ideas assuming that the charged particles in the low-level whirl always have the same sign ; then all spots with the same polarity must also have the same direction of whirl. Further, when the reversal of polarity occurs at sunspot min. there should be a reversal in the direction of whirl. Hale applied this test to the best H vortices observed from 1908 to 1924 and was unable to find any relationship between the polarity and the direction of whirl. But since about 80% of the whirls were in the same direction as terrestrial cyclones, he concluded that the observations favoured the hydrodynamical rather than the electromagnetic hypothesis. This test has been repeated, using all the observations from 1908 to 1939, extending over 4 sunspot cycles. The results obtained agree closely with those of Hale. Evidently, the direction the vortex takes is determined primarily by the solar rotation. Author.

GEOPHYSICS.

GEOPHYSICS, APPLIED.

536. Motion of the earth's fluid core : a geophysical problem. D. R. Inglis. *Phys. Rev.*, **59**, *pp.* 178–188, *Jan.* 15, 1941.—It is concluded that the axis of rotation of the interior of the core may lag behind the axis of the mantle in the precession by an angle of a few degrees. Apart from superposed eddies, points near the surface of the core would then move relative to the mantle around horizontal closed paths, with a period of 1 day. This would cause a diurnal variation of the earth's magnetism much larger than observed if it were not for the shielding of metallic layers above the core. Author.

HYDROSPHERE, PHYSICS OF THE

537. Effect of coastal friction on the tides. J. Proudman. *Mon. Not. Roy. Astr. Soc. Geophys. Suppl.*, **5**, 1, *pp.* 23–26, 1941.—It is pointed out that the age of the tide is positive for the great majority of the places open to the oceans at which tides have been observed. In the past various indications have been given that this phenomenon is due to the action of friction in shallow water. A boundary condition for the deep ocean, which corresponds to a large dissipation of energy on the continental shelf, is derived. This boundary condition is first applied to a particular case of the forced tides in a flat channel on a rotating Earth, and it is shown that the age of the tide is predominatingly positive. The condition is next applied to an ocean bounded by a circle of latitude and evaluated for a hemispherical ocean bounded by the equator. Again positive ages are obtained, and the pattern of cotidal lines is very different from that corresponding to zero dissipation.

Author.

538. Temperature of lakes. R. Emden. *Helv. Phys. Acta*, **13**, 5, *pp.* 396–434, 1940. *In German.* —In order to investigate the temperature distribution in a lake a simpler problem is examined, in which convection is neglected. Under the influence of radiation a negative temperature gradient is first obtained because the radiation is absorbed and therefore heats only the top layers. However, a steady state can only be reached if heat is conducted upwards, and this requires a positive temperature gradient. Convection would not alter this result because in a negative gradient no convection would occur. The influence of the diurnal and annual variation of the radiation is discussed. R. P.

LAND, PHYSICS OF THE

539. General theory of 3-dimensional consolidation. M. A. Biot. *J. Appl. Phys.*, **12**, *pp.* 155–164, *Feb.*, 1941.—The settlement of soils under load is caused by consolidation; the mechanism is in many cases identical with squeezing water out of an elastic porous medium. The number of physical constants necessary to determine the properties of the soil is derived, with the general equations for the prediction of settlements and stresses in 3-dimensional problems. The operational calculus is used. AUTHOR.

See also Abstract 473.

METEOROLOGY.

540. Evolution of the atmosphere. J. H. J. POOLE. *Sci. Proc. Roy. Dublin Soc.*, **22**, 36, *pp.* 345–365, *Feb.*, 1941.—On geochemical grounds it is known to be highly probable that the primitive atmosphere contained no free oxygen. An attempt is made to calculate its constitution from the available data supplied by the average composition of the igneous and sedimentary rocks of the lithosphere and the probable total amount of igneous rocks denuded during geological time. The total amount of free C at present buried in the sedimentary rocks could not have been derived from the CO_2 in the primitive atmosphere. It is suggested that, possibly, a large quantity of CH_4 was present in this atmosphere. The growth of free O in the atmosphere is discussed. The original liberation of free O is attributed to the photo-dissociation of water vapour in the upper atmosphere, combined with the high temperature of this region, which leads to the gradual escape of H, thus leaving free O behind in the atmosphere. It is assumed that by this method enough O could be finally accumulated in the atmosphere to enable plant life to start and then produce by the photosynthetic decomposition of CO_2 the main part of the free O, which is at present in the atmosphere or has been used up during geological time in the formation of the sedimentary rocks AUTHOR.

*541. **Distribution of ozone in the stratosphere: measurements of 1939 and 1940.** W. W. COBLENTZ AND R. STAIR. *Bur. Stand. J. Res. Wash.*, **26**, *pp.* 161–174, *Feb.*, 1941.—Continuing the measurements of ultra-violet solar radiation intensities made in 1937 and 1938 [Abstr. 2801 (1939)] a description is given of similar measurements with improved apparatus. The apparatus that was transported aloft by unmanned balloons consisted of the following: (1) a photocell and filter radiometer, connected with a balanced amplifier, relaxation oscillator and radio transmitter; (2) a radio-operated barometer, giving the heights; and (3) an electrolytic resistor for measuring the ambient temperature. The a.f. modulated radio wave, giving (1) the intensity of the incident ultra-violet solar radiation, (2) the elevation of the apparatus, and (3) the temperature of the meter, was received and graphically recorded at a fixed ground station. The radiometer attained heights ranging from about 78 000 to about 88 000 ft. It is deduced that the apparatus passed through 65 to 70% of the ozone, most of which is localized in a layer extending from 15 to 27 km. with a wide max. conc. at about 24 to 25 km. above the earth's surface. At the highest elevation the intensity of the ultra-violet solar radiation of wavelengths shorter than 3 132 Å was 10 to 12 times that observed at sea level. AUTHORS.

542. Effects of tropospheric and stratospheric advection on pressure and temperature variations. C. M. PENNER. *Canad. J. Res. A*, **19**, *pp.* 1–20, *Jan.*, 1941.—Pressure and temperature variations at Sault Ste. Marie during 1938–39 for all levels up to 20 km. have been studied. The pressure extremes are progressively retarded at higher levels in the troposphere, while in the stratosphere the retardation decreases so that the phase becomes more nearly that of the surface pressure. The temperature extremes at greater altitudes in the troposphere are advanced with respect to the surface values. In the stratosphere the temperature variation reverses phase. Pressure and temperature anomalies are discussed in their relation to advection. High surface pressures are accompanied by a warm troposphere and a cold stratosphere. The opposite is true of low surface pressures. Seasonal differences in pressure and temperature variations are discussed. AUTHOR.

*543. **Absolute measurement of total radiation from the sky.** Y. KATÔ AND T. SATÔ. *Sci. Rep. Tôhoku Univ.*, **29**, *pp.* 343–355, *Nov.*, 1940.—A modification of Ångström's electric compensation pyrheliometer has been constructed and used to determine the total radiation from the sky. Experimental data are compared with values calculated from Berlage's formulae and good agreement is obtained. Possible sources of error are discussed. W. R. A.

544. Measurement of the total amount of radiation from the whole sky and the atmospheric transmission coefficient. T. SATÔ. *Sci. Rep. Tôhoku Univ.*, **29**, *pp.* 356–383, *Nov.*, 1940.—Actinographs of a Gorczinsky pyranometer for the period April, 1937, to February, 1940, have been examined and atmospheric transmission coefficients have been determined for fine days. The formula of Berlage is supported. Low values for transmission coefficients in July and August, approximately the same annual values, are attributed to the large amounts of water vapour present in the atmosphere during these months. W. R. A.

*545. **New electrical weight barograph.** J. PATTERSON AND W. E. K. MIDDLETON. *Quart. J. Roy. Met. Soc.*, **67**, *pp.* 19–31, *Jan.*, 1941.—An account is given of a new weight barograph which resembles that of Sprung in principle but differs almost entirely in detail. Its mechanism is driven electrically and provides not only a clear graphical trace of the pressure but a printed numerical record of its value every hour. The usefulness of this lies not so much in facilitating the abstraction of the data from the charts as in adding materially to the accuracy; for changes in humidity have a decided effect on the width of the paper and may under extreme conditions cause an error of a millibar in the trace. The barometric tube and a counterweight hang from the ends of a beam, pivoted at its centre, and on the beam is a rolling weight; when the beam is slightly tilted by a change of pressure a contact is made which through a sensitive relay brings into operation an electric motor. This moves the rolling weight until equilibrium is again reached and the position of the rolling weight controls both the trace and the number printed. After a discussion of the fundamental principles the mode of construction is described in some detail and, finally, the methods of adjustment and the compensation for temperature. AUTHORS.

546. Highest and lowest sea-level pressures observed in the United States. E. H. BOWIE. *Mon. Weat. Rev., Wash.*, **68**, *pp.* 241–242, *Sept.*, 1940.

547. Variations in annual, seasonal and monthly rainfall over the British Isles, 1870-1939. J. GLASSPOOLE. *Quart. J. Roy. Met. Soc.*, **67**, *pp.* 5–14, *Jan.*, 1941.—The paper includes statistics of the general monthly rainfall over the British Isles, both in inches and as percentages of the average, for 1870–1939. The general trend of the variations is shown by diagrams of 10-year means for each month, based on the similar statistics for England and Wales, Scotland and Ireland separately. Similar diagrams are given to show the variations for the winter half-year, summer half-year and seasonal year separately. AUTHOR.

548. Evaporation loss per month over drainage areas. II. Loss over 3 areas. D. LLOYD. *Quart. J. Roy. Met. Soc.*, **67**, *pp.* 33–38, *Jan.*, 1941. —The data from 3 more large drainage areas are examined by the same method as in the former paper [Abstr. 2084 (1940)]. The results show again that the variations in loss can be largely associated with variations in rainfall and temperature. It is also demonstrated that, with similar climatic conditions, the loss increases as the subsurface has increasing permeability. AUTHOR.

549. Further cartographic studies of drought. W. R. BALDWIN-WISEMAN. *Quart. J. Roy. Met. Soc.*, **67**, *pp.* 39–46, *Jan.*, 1941.—After stating the need for precise drought data as the basis for the formulation of sound economic schemes of insurance of stock and crops against losses arising from drought, the author outlines methods by which all the requisite essential data can be derived from lengthy meteorological records: (1) In precise month-to-month detail, with regard to all the major droughts of a review period, by means of isodef charts showing equal percentage deficiency, and (2) in general detail for the whole review period, which is limited only by the availability of an adequate supply of reliable continuous meterological records, by means of isoagdef charts (showing equal aggregate deficiency). Three typical isoagdef charts for S.E. Queensland, covering the period 1886–1935, together with sample data used in their preparation, are given in illustration of the method. It is also pointed out that the statistical data and charts are of material value in selecting reserve agistment areas, or in deciding leasehold or freehold values of pastoral and farming properties in recurrent-drought areas. AUTHOR.

SEISMOLOGY.

550. Correction of epicentres by least squares. L. J. COMRIE. *Mon. Not. Roy. Astr. Soc. Geophys. Suppl.*, **5**, 1, *pp.* 27–29, 1941.

TERRESTRIAL ELECTRICITY AND MAGNETISM.

551. Distribution of electricity in thunderclouds. II. G. SIMPSON AND G. D. ROBINSON. *Proc. Roy. Soc. A*, **177**, *pp.* 281–329, *Feb.* 24, 1941.—The investigation of the distribution of electricity in thunderclouds [Abstr. 3499 (1937)] has been continued at Kew Observatory. Alti-electrographs, which record the sign of the potential gradient, are sent up on small free balloons. Additional observations made during 8 thunderstorms in the year 1937, 1938 and 1939 are discussed and the conclusions reached by Simpson and Scrase are confirmed. Each thundercloud has positive electricity in the upper half of the cloud, negative electricity in the lower half and in most storms, if not in all, there is a concentrated positive charge below the main negative charge. The generation of the positive and negative charges in the main body of the cloud is ascribed to the impact of ice crystals and that of the positive electricity in the base of the cloud to the breaking of rain drops in an ascending current of air. AUTHORS.

552. Geomagnetic tides in *H* at Huancayo. II. J. BARTELS AND H. F. JOHNSTON. *Terr. Mag. Atmos. Elect.*, **45**, *pp.* 485–512, *Dec.*, 1940.—The authors introduce a new principle of efficient sampling in geographical statistics, applicable to problems where a small quantity, q, is to be derived from a large number of observations of a phenomenon p in which fluctuations greater than q occur. The usual deviation from random conditions is accounted for by a parameter ϵ_n—the equivalent number of repetitions—n/ϵ_n being the number of effectively independent observations. The principle is applied to the problem discussed previously [Abstr. 3120 (1940)] and a new expression is derived for the average geomagnetic tidal effect of the mean moon on H. Tables and diagrams illustrate the method of calculation. Ed.

RADIOACTIVITY.

553. Radioactivity of ocean sediments. III. Radioactive relations in ocean water and bottom sediment. C. S. Piggot and W. D. Urry. *Amer. J. Sci.*, **239,** *pp.* 81–91, *Feb.*, 1941.—[See Abstr. 4512 (1939).] There is much less radium in the ocean water and much more in the bottom sediment than is appropriate to the U present in each place. Studies of core samples of deep ocean sediments, several metres long, reveal that some mechanism exists which removes radium and its immediate parent ionium from the water and leaves most of the U behind. The ionium produces more radium, and the excess of these 2 elements, unsupported by U, eventually disappears, leaving an equilibrium based on the small U content—which is of the same order of magnitude as is found in ordinary sedimentary rocks. It is now apparent that the high radium content of the ocean sediments is transitory and of no great geophysical significance. Several mechanisms for this separation and concentration are discussed. Authors.

554. Branching ratios in the fission of U (235). H. L. Anderson, E. Fermi and A. V. Grosse. *Phys. Rev.*, **59,** *pp.* 52–56, *Jan.* 1, 1941.—A survey has been made of the percentages of slow neutron-induced U fissions that give rise to the formation of various radioactive series. These percentages were obtained by measuring the number of β-disintegrations of a suitable member of the series after an irradiation under specified geometrical conditions and a quantitative chemical separation. The percentages found for the series thus far investigated vary from about 0·1% to 10%. Authors.

555. Photo-fission of U and Th. R. O. Haxby, W. E. Shoupp, W. E. Stephens and W. H. Wells. *Phys. Rev.*, **59,** *pp.* 57–62, *Jan.* 1, 1941.—Fission of U and Th has been observed to be produced by irradiation with γ-rays. The cross-section for this photo-fission produced by the γ-ray from fluorine bombarded with protons has been measured. Authors.

556. Measurement of artificial radioactivity in liquid tracer samples using C^{11}. J. H. C. Smith and D. B. Cowie. *J. Appl. Phys.*, **12,** *pp.* 78–82, *Jan.*, 1941.—Using C^{11} as tracer for the study of CO_2 absorption in plants, a satisfactory technique was developed. A degree of precision was obtained so that after the elapse of 6 half-lives (2 hrs.) the sum of the activities taken from the reaction system was accurate to 1 or 2%. This required the determination of an accurate half-life value for C^{11} (20·35 min.). The experimental procedures are described. Authors.

557. Scattering of α-particles in He. J. A. Wheeler. *Phys. Rev.*, **59** *pp.* 16–26, *Jan.* 1, 1941.—Deviations from the scattering to be expected on the basis of an inverse square law of force between α-particles receive a satisfactory interpretation in terms of the influence on particles of 0, 2 and 4 units of angular momentum of a specific nuclear interaction having a range less than 9×10^{-13} cm. The semi-stable state of the compound nucleus Be^8 formed in certain disintegration experiments is found from the scattering analysis to have an energy of about 3 eMV, a mean life of $0{\cdot}8 \times 10^{-21}$ sec., and zero angular momentum. There is also some evidence for a semi-stable state of still shorter life with 2 units of angular momentum and an energy of 4 to 5 eMV. Author.

558. The α-particle model and the properties of the nucleus Be^8. J. A. Wheeler. *Phys. Rev.*, **59,** *pp.* 27–36, *Jan.* 1, 1941.—Reasons are given for renouncing any attempt to interpret the scattering of α-particles in He in terms of a hypothetical law of force between α-particles. The analysis of scattering observations in the preceding paper is employed in conjunction with other information from theory and experiment to draw conclusions about the normal state and the first two excited levels of the compound nucleus Be^8. Author.

559. Interaction of α-particles. H. Margenau. *Phys. Rev.*, **59,** *pp.* 37–47, *Jan.* 1, 1941.—The properties of the forces between α-particles are discussed on the basis of a Heitler-London analysis augmented by a van der Waals calculation. The results are in some respects unfavourable to the α-particle model of the nucleus as they contradict the assumptions. Thus it is pointed out that there are no attractive van der Waals forces beyond the range of the exchange forces, the range of the second-order forces being no greater than that of the first-order forces. The forces between α-particles are not additive. The range of the forces is approximately equal to that of the forces between elementary nuclear particles. The Heitler-London forces are repulsive if the usual choice of a symmetric Hamiltonian is made. The details of the forces are worked out in connection with a simple fictitious example. Calculations for the α-particle, for which a ψ-function of the Gauss type is assumed, are made and the results are used in an examination of the problem of the scattering of α-particles in He. It appears that the scattering of the *S* waves can be explained only partially by means of the present interaction, its fault being the failure to produce resonance at the correct energy. AUTHORS.

560. β-ray spectra of light elements. A. A. TOWNSEND. *Proc. Roy. Soc. A*, **177**, *pp.* 357–366, *Feb.* 24, 1941.—A magnetic spectrometer has been used to investigate the β-ray spectra of some elements of low atomic number. It is found that all the spectra follow the Fermi distribution law for a certain range from the high-energy end-point; the range over which this is true is much greater if the max. energy is large. The end-points found are: C^{11} 0·981 ± 0·005 eMV, N^{13} 1·218 ± 0·004 eMV, Mn^{56} 2·88 ± 0·01 and 1·035 ± 0·015 eMV, Cu^{64} (positrons) 0·649 ± 0·004 eMV, Cu^{64} (negatrons) 0·574 ± 0·004 eMV, Zn^{63} 2·320 ± 0·005 eMV. AUTHOR.

561. Measurement of γ-radiation in roentgens. T. N. WHITE, L. D. MARINELLI AND G. FAILLA. *Amer. J. Roentgenol. and Radium Ther.*, **44**, *pp.* 889–903, *Dec.*, 1940.—Ref. is made to a previous paper [Abstr. 4724 (1937)] in which the ionization between 2 concentric spherical shells produced by filtered γ-radiation was determined. The value differed from that obtained by a thimble ionization chamber. The present research was intended to determine the origin of this difference by use of shells of different dimensions. A physical constant is introduced, defined as the specific effective γ-ray intensity of radium. Factors modifying the values of the thimble-chamber method, such as wall thickness and material, cavity size, etc., are discussed and the distribution of energy is treated mathematically, followed by precise details of construction of the spherical ionization chamber utilized. It is found that discrepancies can be explained by introduction of certain theoretical considerations and, within an error of 2%, the value of radiation can be defined in r./g./min. at 1 cm. distance or r./mg./hr. at 1 cm. distance. B. J. L.

RADIATION.

ABSORPTION.

562. Optical properties of rubber. L. A. WOOD. *J. Appl. Phys.*, **12**, *pp.* 119–126, *Feb.*, 1941.—The following properties of rubber are discussed: absorption, scattering, refractive index and double refraction. A general survey of the results of previous work is given. Some possibilities for future investigation are indicated. New experimental data are presented for the transmission values of milled pale crêpe and a soft vulcanized rubber compound at wavelengths from 400 to 750 mμ. The results of some measurements on scattering are included. The variation of refractive index with wavelength is given, as calculated from unpublished measurements of the angles of min. deviation of prisms of unvulcanized and of vulcanized rubber. AUTHOR.

563. Exchange effects in the theory of the continuous absorption of light. I. Ca and Ca^+. D. R. BATES AND H. S. W. MASSEY. *Proc. Roy. Soc. A*, **177**, *pp.* 329–340, *Feb.* 24, 1941.—The continuous absorption coefficients of normal Ca and Ca^+ are calculated. Both the discrete and continuous wave functions used in the calculation include the effect of electron exchange. Comparison is effected with results obtained neglecting exchange and it is found that appreciable modifications are introduced by its inclusion. This is particularly true for Ca^+ which is a sensitive case owing to very strong interference in the integrand of the transition matrix element. The bearing of the results on the calculation of absorption coefficients in general is discussed, and it is pointed out that the discrepancy between theory and experiment for K arises because this also is a very sensitive case. An application of the results for Ca is made to resolve a discrepancy between determinations of interstellar electron densities carried out using different methods by Strömgren and Struve. AUTHORS.

COLORIMETRY.

564. Colorimetric analysis of a 2-component colour system. H. W. KNUDSON, V. W. MELOCHE AND C. JUDAY. *Industr. Engng Chem.* (*Analytical Edition*), **12,** *pp.* 715–718, *Dec.* 16, 1940.—It is shown in theory and practice how photoelectric filter photometers can be used to resolve the intensity of one colour in presence of another in the solution owing to an interfering ion or substance. One method depends on the isolation of part of the absorption band of the desired component by means of a suitable filter; the other method depends on the differential separation of the absorption bands by 2 selected filters. Calculation of the concentration of one component in unknown mixtures with a second component is given. Theory is supported experimentally by data for the Al-Fe-hematoxylin system. The method can be used to determine traces of Al in natural waters containing only small amounts of Fe. N. M. B.

EMISSION.

565. Electric fields produced by cosmic rays. F. EVANS. *Phys. Rev.*, **59,** *pp.* 1–7, *Jan.* 1, 1941. —With recognition of the existence in interstellar space of a finite density of matter, the following assumptions are made : (1) The current is related to the electric field producing it by Ohm's law ; (2) the interchange of electric charge between a star and its surroundings has reached a steady state ; (3) the conditions around a star are spherically symmetric, which implies that the star has no magnetic moment ; (4) the forces due to gravity, radiation pressure and diffusion, can be neglected simultaneously. The validity of these assumptions is discussed. The electric field E in the neighbourhood of a single star is given by the equation, $A = -\sigma r^2 E$, where A is proportional to the rate at which the star intercepts or emits cosmic-ray particles all of the same charge, σ is the electrical conductivity in interstellar space, and r is the distance from the centre of the star. It is found that both charge density and current density vanish in interstellar space. Numerical calculations indicate that the star will acquire a very small potential when it only intercepts cosmic rays. For a typical star this is of the order of 10^{-12} V. In the case of emission an upper limit to the potential is found to be approximately 1 V. The limitations of the applicability of the analysis for the case of emission are discussed. It is concluded that the existence in interstellar space of cosmic rays as charged particles predominantly of one sign will result in the production of negligible electric fields. Calculations are made to determine the dimensions of the ion sheath that will be produced around a star by the ions in interstellar space. AUTHOR.

566. Cloud tracks of cosmic rays in the substratosphere. G. HERZOG. *Phys. Rev.*, **59,** *pp.* 117–122, *Jan.* 15, 1941.—A cloud chamber in a magnetic field of 708 oersteds was carried in an aeroplane to a height of 29 300 ft. The max. measurable $H\rho$ was $5{\cdot}6 \times 10^5$ which, for an electron, corresponds to an energy of $1{\cdot}7 \times 10^8$ eV. Out of 155 pictures taken at altitudes greater than 15 000 ft. 51 slow mesotrons and 39 proton tracks were identified. The number of slow mesotron tracks at these altitudes is 9% of the number of electron and fast mesotron tracks. One photograph seems to show a slow mesotron shower. Some of the tracks with very high specific ionization may be due to the fragments of heavy nuclei. AUTHOR.

567. Cloud-chamber pictures of cosmic rays at 29 000 ft. altitude. G. HERZOG AND W. H. BOSTICK. *Phys. Rev.*, **59,** *pp.* 122–126, *Jan.* 15, 1941.—Cloud-chamber pictures (115 in number) of cosmic rays were taken during an aeroplane flight. The range of slow mesotrons was investigated by inserting a copper plate across the middle of the chamber. The slow mesotron rate above 15 000 ft. is 9·6% of the occurrence rate of electrons and fast mesotrons. The formation of a pair of positive and negative slow mesotrons was photographed. Statistical evidence is given that mesotrons do not always disintegrate when stopped. One proton was photographed. AUTHORS.

568. Latitude effect of cosmic rays above 50° N. latitude. P. F. GAST AND D. H. LOUGHRIDGE. *Phys. Rev.*, **59,** *pp.* 127–129, *Jan.* 15, 1941.—The latitude effect for cosmic rays above 50°N. magnetic latitude has been measured by a continuously operating, ionization type meter mounted on shipboard. From these data the monthly mean temperature coefficient is found to be $-0{\cdot}09 \pm 0{\cdot}03\%$/deg.C. When this correction is applied to the data, the latitude/intensity curve is found to be flat within the limits of the probable error over the range of magnetic latitudes from 53° 30′ N. (Seattle) to 61° 36′ N. (Juneau). AUTHORS.

569. E.-W. asymmetry of cosmic radiation at high latitudes. F. G. P. SEIDL. *Phys. Rev.*, **59,** *pp.* 7–10, *Jan.* 1, 1941.—The sea-level E.-W. asymmetry of unabsorbed cosmic radiation and of that radiation penetrating 2 thicknesses of lead, 20° from the vertical, has been measured at geomagnetic latitude 54°N., well above the knee of the latitude effect. Two methods were used to calculate the asymmetry from the data. AUTHOR.

570. E.-W. asymmetry of cosmic radiation in high latitudes and excess of positive mesotrons. T. H. JOHNSON. *Phys. Rev.*, **59,** *pp.* 11–15, *Jan.* 1, 1941.—The slight E.-W. asymmetry is interpreted as the result of the deflection by the earth's magnetic field of the mesotron component while the rays are losing energy by ionization in the atmosphere. Since this component contains about 20% more positive than negative rays these deflections result in an asymmetry. Orbits of rays, including those in the range of energy where rest mass cannot be neglected, have been investigated and the deflections determined. It is assumed that deflections without energy loss, namely those of the primary rays described by the theory of Lemaître and Vallarta, result in a symmetrical distribution for the energy ranges concerned. The asymmetry is traced to the difference between the actual deflection and that of a ray which loses no energy. The difference deflection δ shifts the angular distribution so that rays which, in the absence of a field, would have produced an intensity proportional to $\cos^2 \zeta$ actually produce this intensity at an angle $\zeta + \delta$. Asymmetries calculated in this way agree with the observed values and give the correct variation of asymmetry with zenith angle and elevation. AUTHOR.

FLUORESCENCE AND PHOSPHORESCENCE.

LUMINESCENCE AND AFTERGLOW.

571. Fluorescence of 3-atomic In halogenides. W. WENK. *Helv. Phys. Acta*, **13,** 5, *pp.* 345–346, 1940. *In German.*

572. Carcinogenic hydrocarbons. V. Comparison of the fluorescence intensity of cholanthrene and certain of its homologues. W. F. BRUCE. *J. Amer. Chem. Soc.*, **63,** *pp.* 304–305, *Jan.*, 1941. —A study of fluorescence intensities in some homologous 20-substituted cholanthrenes has shown that the fluorescence intensity increases in a comparison of cholanthrene and methylcholanthrene. In the higher homologues the rapid decline in carcinogenic activity is not accompanied by a corresponding decline of fluorescence intensity, which remains nearly the same for these substances when equi-molecular concentrations are used. AUTHOR.

INTERFERENCE, DIFFRACTION AND SCATTERING.

573. New experiment on interference of diverging beams of light. R. W. POHL. *Phys. Z.*, **41,** *pp.* 498–499, *Nov.* 15, 1940. *In German.*—The author describes a simple method for showing interference rings to a large audience. A sheet of mica is put a few cm. behind a small technical mercury arc lamp. The beams reflected on the back and the front plane of the sheet are thrown on a screen which is shielded against the direct light of the lamp. No special adjustment is required as with Fresnel's arrangement. As an example the following figures are given : thickness of mica sheet 0·04 mm., distance between screen and mica sheet 3 000 mm., angle of incidence 45°. R. N.

574. Interference phenomena with a moving medium. H. E. IVES AND G. R. STILWELL. *J. Opt. Soc. Amer.*, **31,** *pp.* 14–24, *Jan.*, 1941. – Earlier studies of phenomena characteristic of optical interference by observations of interference patterns of capillary waves on liquids have all been made with source stationary as regards the liquid. The work described here deals with the same problems for the case of relative motion of source and liquid. The main experimental innovation is the avoidance of contact with the liquid (such as would be given by a plunger), all the effects being produced by air jets. The work shows that, given invariance of the phenomena with motion, it is possible to derive the Fitzgerald contraction, the Larmor-Lorentz change of clock rate, and the Fresnel convection coefficient. A. H.

575. Criteria and the intensity/epoch slope. B. P. RAMSAY E. L. CLEVELAND AND O. T. KOPPIUS. *J. Opt. Soc. Amer.*, **31,** *pp.* 26–33, *Jan.*, 1941.—Continuing earlier work [Abstr. 3148 (1940)] the various criteria for limit of resolution (Rayleigh, Schuster, Sparrow, Ditchburn, Houston and Buxton) are discussed at length, classified and compared. The method of using each criterion in connection with the intensity/epoch slope is given, but no novel criterion for resolution is presented. A. H.

See also Abstract 562.

PHOTOCHEMISTRY (INCLUDING PHOTOGRAPHY).

576. Molecular extinction coefficients of dissolved iodine in the photographic infra-red region. T. S. HSIUNG. *Sci. Rep. Tsing Hua Univ.*, **4,** 2–3, *pp.* 243–247, 1940.—By the method of photographic matching the molecular extinction coefficients of dissolved iodine in carbon tetrachloride, benzene, methyl alcohol and ethyl alcohol, are determined for the wavelength region 4000 Å to 10000 Å. AUTHOR.

577. Proposed American standard : specifications for determining photographic speeds of roll films, film packs and miniature camera films. *J. Opt. Soc. Amer.*, **31,** *pp.* 87–92, *Jan.*, 1941.

***578. Time-saving adaptation for photomicrography.** J. A. QUENSE AND W. M. DEHN. *Industr. Engng Chem.* (*Analytical Edition*), **13,**

p. 68, *Jan.* 15, 1941.—In the taking of a photomicrograph with a camera carrying a view tube attached to the microscope it is necessary to remove the camera for the manipulation of a cap nicol analyser and then replace it to take the photograph. A device is described which renders the removal of the camera unnecessary. A. J. M.

579. Effect of resonance on the activity of some developing agents. E. C. ARMSTRONG, T. H. JAMES AND A. WEISSBERGER. *Commun. No.* 787 *Kodak Res. Lab. J. Amer. Chem. Soc.*, **63,** *pp.* 182–185, *Jan.*, 1941.—The developing activity and autoxidation rate of various derivatives of hydroquinone, some of which are new, and the developing activity of 2,3-dihydroxybenzoic acid were determined. It is shown that the inactivation of developing agents of the type of di- and trihydroxybenzenes caused by the introduction of carboxylic-acid groups or of nitro groups is largely due to the stabilization of the anions by resonance. Four compounds which do not obey the Lumière-Andresen rules for the structure of developing agents were proved to have developing activity. AUTHORS.

580. Optical sensitizing of silver halides by dyes. III. Relation of sensitizing to absorption spectra and constitution of dyes. S. E. SHEPPARD, R. H. LAMBERT AND R. D. WALKER. *Commun. No.* 774 *Kodak Res. Lab. J. Chem. Phys.*, **9,** *pp.* 96–113, *Jan.*, 1941.—The necessary and sufficient conditions for sensitizing are deduced, and on these bases a hypothesis of coplanar coupling of electronic displacements in the dye and in a congruent plane of the silver halide lattice is advanced. It is suggested that this is a key factor in optical sensitizing by dyes, both for molecular and aggregate sensitizing. Certain other relations of constitution to sensitizing are discussed, including the influence of nuclear (perichrome) changes and of substitution. [See Abstr. 2875 (1939).] AUTHORS.

581. Theory of the half-tone process. I. The penumbra theory. J. A. C. YULE. *Commun. No.* 786 *Kodak Res. Lab. J. Franklin Inst.*, **231,** *pp.* 23–38, *Jan.*, 1941.—A method of calculating the tone reproduction curve of a halftone from the light distribution behind the halftone screen, or vice versa, is described. The actual light distribution is found to check satisfactorily with the distribution calculated from geometrical optics, i.e. penumbra theory, when coarse screens and abnormally short screen distances are used, except in the regions of very low light intensity. With fine screens and normal screen distances both dot shape and tone reproduction differ markedly from the calculated results and can only be explained by the effects of diffraction. AUTHOR.

582. Photographic latent image. N. F. MOTT. *Photogr. J.*, **81,** *pp.* 63–69, *Feb.*, 1941.—A lecture report describing experiments arising from the Gurney-Mott theory of latent image formation and their explanation in terms of that theory. The experiments deal with the mechanism of solid reactions in ionic crystals, the photo-conductivity of the Ag halide and the release of one electron per quantum of light absorbed, the mechanism of latent image formation (with confirmatory experiments at liquid-air temperature) and the explanation of solarization or photographic reversal, the Herschel effect, reciprocity breakdown at high and low intensities, and the Clayden effect. N. M. B.

PHOTOMETRY.

***583. Microphotometer for spectrochemical analysis.** E. M. THORNDIKE. *Industr. Engng Chem.* (*Analytical Edition*), **13,** *pp.* 66–67, *Jan.* 15, 1941. —A simple microphotometer, which can be constructed from standard laboratory equipment, is described. The performance of the instrument is satisfactory, though it is rather slow. A. J. M.

***584. Concave grating photo-electric spectrophotometer.** C. SHEARD AND M. N. STATES. *J. Opt. Soc. Amer.*, **31,** *pp.* 64–69, *Jan.*, 1941.—In this instrument (called a spectrophotelometer) the monochromator is essentially of the Eagle type of mounting, whilst a barrier-layer photocell is employed to measure the light intensity. A. H.

POLARIZATION.

585. Effect of rotation of groups about bonds on optical rotatory power. W. KAUZMANN AND H. EYRING. *J. Chem. Phys.*, **9,** *pp.* 41–53, *Jan.*, 1941. —It is shown that the numerical value of the optical activity of a compound is reduced if the groups surrounding the asymmetric atoms in the compound possess a 3-fold axial symmetry about the bonds connecting them with the atoms. This 3-fold symmetry may be inherent in the groups themselves or it may be acquired through the free rotation of the groups about these bonds or by their orienting themselves to equal extents in each of the 3 possible equilibrium positions about each bond. The order of magnitude of the numerical value of the optical activity is thus a measure of the freedom of orientation about single bonds of the groups in an asymmetric molecule. The structures of certain sulphur compounds, polypeptides and proteins, are discussed in the light of the magnitudes of their optical activities. AUTHORS.

See also Abstract 562.

REFLECTION, REFRACTION AND DISPERSION.

586. Reflection characteristics with polarized light. J. Laurence. *J. Opt. Soc. Amer.*, **31,** *pp.* 9–13, *Jan.*, 1941.—Quantitative data of the reflection characteristics of printed matter under natural and polarized light are discussed. The use of light whose *E* vector is polarized in the plane of incidence is found to decrease the reflected glare and to increase the contrast between the printed characters and their background. Results on the degree of depolarization of light reflected from worsteds show that dark cloth causes little depolarization, whereas light cloth depolarizes almost completely. Metallic surfaces depolarize very little. Moreover, the reflection factor of metals is almost independent of the plane of polarization of the incident beam, whereas the reflection factor of non-metallic surfaces is greatly affected by the plane of polarization. Author.

587. Note on the best focus in the presence of spherical aberration. Wang Ta-Hang. *Proc. Phys. Soc., Lond.*, **53,** *pp.* 157–169, *March*, 1941. —The location of the best axial focus of an optical system in the presence of spherical aberrations of various orders is considered upon the criterion of max. axial light intensity. Adhering to Rayleigh's quarter-wavelength limit, it is shown by approximate formulation that for axial aberrations sensible up to the primary, secondary and tertiary order, the allowable tolerance for such parts of the aberrations when stated in terms of optical path-difference can reach λ, 4λ and 15λ, respectively, provided that the foci of various zones are suitably controlled in design. Author.

588. Densities and refractive indices of liquid paraffin hydrocarbons. M. L. Huggins. *Commun. No.* 756 *Kodak Res. Lab. J. Amer. Chem. Soc.*, **63,** *pp.* 116–120, *Jan.*, 1941.—Molal volumes of normal paraffins are given quite accurately by an equation of the form $V_n = a + bn + (c/n)$. Molal volumes of several series of non-normal paraffins are given quite accurately by relations of the form $\boldsymbol{V} = V_n + d$. Molal refractions of paraffins in general are, quite accurately, the sums of characteristic bond refractions. The magnitude of a C-C or C-H bond refraction depends on the number of C and H atoms attached to each of the C atoms concerned. Simple equations for computing molal refractions (and refractive indices) of paraffins from their formulae have been deduced and tested. Author.

See also Abstracts 504, 562.

SPECTROSCOPY.

589. General theory of spectra. II. M. H. Stone. *Proc. Nat. Acad. Sci., Wash.*, **27,** *pp.* 83–87, *Jan.*, 1941.—Continuing earlier work on the "algebraization" of spectral theory [Abstr. 2138 (1940)] a further contribution is made on the theory of lattice-ordered Abelian groups. The paper is entirely mathematical. A. H.

590. Distribution of energy in the visible spectrum of daylight. A. H. Taylor and G. P. Kerr. *J. Opt. Soc. Amer.*, **31,** *pp.* 3–8, *Jan.*, 1941.

591. Notes on the physical basis for spectrographic analysis. W. F. Meggers. *J. Opt. Soc. Amer.*, **31,** *pp.* 39–46, *Jan.*, 1941.—A survey article summarizing investigations dealing with the physical basis of spectrographic analysis. The conclusions reached are: Among conventional light sources electric arcs are best qualified to excite the first spectra of the elements. The strongest lines invariably result from a transition between *s* and *p* electrons in the atoms. If the configuration for the normal state contains a single *s* electron the atoms have extraordinary spectral sensitivity. Valence electrons of *p* type are more firmly bound, so that noble gases, halogens and metalloids have relatively low spectral sensitivity. Differences in absolute sensitivity appear to be related to atomic structure, mainly on account of differences in binding forces on *s* and *p* electrons. A. H.

592. Application of infra-red spectroscopy to industrial research. N. Wright. *Industr. Engng Chem.* (*Analytical Edition*), **13,** *pp.* 1–8, *Jan.* 15, 1941.—A review, referring especially to the qualitative and quantitative analysis of organic compounds by infra-red spectroscopy as a routine method in an industrial laboratory. The detection and identification of impurities, such as ethylidene chloride in chloroform, and 1,2-dibromopane in the 1,3-compound, are described. A method for the quantitative estimation of impurities in organic compounds has also been elaborated. Infra-red spectroscopy can also be used to detect and identify intermediate products in reactions and is thus of value in determining the mechanisms of reactions. A. J. M.

593. Influence of extraneous elements on line intensity. III. Effect of anions. W. R. Brode and E. S. Hodge. *J. Opt. Soc. Amer.*, **31,** *pp.* 58–63, *Jan.*, 1941.—Investigates the effect which the presence of anions may produce on line intensity. It is found that in a given series of compounds of different anions but common cation the line intensity of the cation is greatest for those compounds having the lowest boiling point. When anions are present as an extraneous substance, those which tend to give subhalide band spectra have relatively greater effect than compounds tending to break down to CaO. The repression of the line intensity generally becomes greater for larger concentrations of the elements being measured, and approaches a max. with increasing conc. of

CaF_2. It is shown that this effect may be caused by the lower energy necessary to excite the band spectra of CaF_2 than the lines under consideration. A. H.

594. Note on a spectrographic study of Central American and Asiatic jades. D. NORMAN AND W. W. A. JOHNSON. *J. Opt. Soc. Amer.*, **31**, *pp.* 85–86, *Jan.*, 1941.—Analyses are made of 32 jade samples in order to see whether information on the source of Maya jade is obtainable. No marked chemical difference between the jades of America and those of the orient are found. A. H.

595. Quantitative determination of P in phosphor bronze. A spectrographic study. W. E. MILLIGAN AND W. D. FRANCE. *Industr. Engng Chem. (Analytical Edition)*, **13**, *pp.* 24–27, *Jan.* 15, 1941.—The essential requirement of arc currents of the order of 10 A is demonstrated. The effect of other factors on the characteristics of the arc is presented, and photometric methods of measuring line intensities are discussed. The resulting arc temperatures eliminated the use of solid metallic electrodes and required the use of the standard regraphitized carbon electrodes with a 200 mg. sample. The proposed method makes possible the spectrographic determination of 0·001% of P in these alloys, within ± 5%. AUTHORS.

596. Resonance broadening of the sodium *D* lines. K. WATANABE. *Phys. Rev.*, **59**, *pp.* 151–153, *Jan.* 15, 1941.—By direct measurement of the contours of the line wings the resonance broadening of the sodium *D* lines in absorption was determined for vapour pressures of Na ranging from 10^{-3} to 70 mm. Hg with negligible amount of foreign gases. Over nearly the entire range the half-intensity width varied linearly with the density of the absorbing atoms. No definite evidence of van der Waals force was observed at the higher pressures ; nor appreciable shifts or asymmetries. The natural width measured was consistent with previous results. AUTHOR.

597. Optical energy levels of Cu^+. Y. YAMAMOTO. *Proc. Phys.-Math. Soc., Japan*, **22**, *pp.* 1048–1052, *Dec.*, 1940.—The numerical values of the intervals between optical levels are computed for the configurations $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9 4s, 5s, 6s$ and $7s$ of Cu^+, according to the general expression of energy levels derived in the previous paper [Abstr. 4332 (1939)]. The self-consistent field radial functions computed by Hartree are used for $1s$, $2s$, $2p$, $3s3p$ and $3d$. Those of $4s$, $5s$, $6s$ and $7s$, are calculated from Hartree's core-functions by numerical integrations. The calculated results are shown in a table. The agreement with experiment is satisfactory. AUTHOR.

598. Paschen-Back effect. VII. Configuration interaction. J. B. GREEN. *Phys. Rev.*, **59**, *pp.* 69–71, *Jan.* 1, 1941.—The spectrum of Kr furnishes a good example of the effect of configuration interaction. The levels $3s_5$ and $4d_2$, belonging to configurations of the same parity, are less than 1 cm.$^{-1}$ apart, and the Zeeman patterns of lines arising from them show large perturbations, both as regards positions and relative intensities of the components. A semi-empirical theory is discussed which leads to agreement with experiment. [See Abstr. 4063 (1939).] AUTHOR.

599. Intensities of the spectral lines of Ne and A. M. SHODA. *Proc. Phys.-Math. Soc. Japan*, **22**, *pp.* 865–881, *Nov.*, 1940.—A study is made of the variation with pressure of the intensity of the total radiation from discharge tubes containing Ne or A. It is shown that, provided the arc column potential does not exceed a certain value, there is a linear relationship between the log of the light intensity for unit current and the log of the voltage drop in the discharge column. For all the lines examined the relationship $G = KA(V_2 - V_1)^n$ is satisfied, G being the light intensity, A the current, $V_2 - V_1$ the arc column potential, n and K constants. A. H.

600. Fine structure in the far infra-red spectrum of NH_3. H. M. FOLEY AND H. M. RANDALL. *Phys. Rev.*, **59**, *pp.* 171–173, *Jan.* 15, 1941.—The pure rotation absorption spectrum of NH_3 for final state $J = 11, 12, 13, 14, 15$ has been examined with high resolution. A multiplet splitting is found which may be expressed by the formula $\nu = 19{\cdot}89J - 0{\cdot}00294J^3 + 0{\cdot}00279JK^2$, where K is the quantum number of angular momentum about the symmetry axis. This equation is shown to be in good agreement with the theoretical expression of Slawsky and Dennison when the potential anharmonicities are taken into account. A calculation of the permanent dipole moment is made from the absolute intensity of one absorption, giving the value $1{\cdot}3 \times 10^{-18}$ c.g.s. e.s.u. AUTHORS.

601. Cu-*K*-absorption spectrum of the alloy Al-Cu and its purification. S. KOKUBO AND T. HAYASI. *Sci. Rep. Tôhoku Univ.*, **29**, *pp.* 385–390, *Nov.*, 1940. *In German.*—A specimen, containing 5% Cu, kept at 545°C. for 30 min. and then slowly cooled to room temperature, gives a fine structure similar to that of $CuAl_2$, whereas specimens heated at 545°C. and either quenched or annealed at 200° and subsequently cooled to room temperature show a different structure. A 3-stage process for the separation of $CuAl_2$ from quenched solid solutions of the alloy is advanced to explain the results. W. R. A.

602. Infra-red spectra of rubber and high polymers. W. C. SEARS. *J. Appl. Phys.*, **12**, *pp.* 35–40, *Jan.*, 1941.—The transmission spectra of thin films of the following materials have been measured between 2·2μ and 14·8μ : crude rubber, soft and hard vulcanized rubber, thermoprene, polyvinylchloride, neoprene and pliofilm. The spectrum of rubber resembles that of the long-chain paraffins more closely than do those of the polymers, polyvinylchloride, neoprene and pliofilm, all of which contain Cl and have distinctive spectra. Vulcanization of rubber with 2·3% sulphur gives rise to no new bands in the region $2{\cdot}2\mu$ to $12{\cdot}5\mu$ characteristic of molecular cross-bending. Some of the bands in these materials are identified with valence vibrations. AUTHOR.

603. Absorption spectrum of reversibly polymerized quinoline dyestuffs. H. ECKER. *Kolloid Zschr.*, **92,** *pp.* 35–70, *July*, 1940. *In German.*—The investigations were carried out with a special spectral photometer measuring the absorption spectra at wavelengths between 4 600 and 6 800 Å with an error of only 2-3%. The absorption spectra of quinoline dyestuffs solved in water are dependent on the concentration and on temperature. The results of the investigations lead to the conjecture that these dyes polymerize reversibly in 2 steps, forming at first a double molecule and then a highly polymerized product showing in some instances fluorescence, high viscosity and elasticity. The absorption bands are of great height and small width. The *p*-electrons appear to be tightly coupled. With other solvents except H_2O and D_2O, e.g. H_2S, NH_3, HCN and C_2H_5OH, no polymerization takes place and no narrow band appears. The dependence of the spectrum on concentration and temperature permits of determining the degree of polymerization. The reaction heat on adding one molecule either to the double molecule or to the highly polymerized product was found to be 7 kcal. R. N.

604. Analysis of rotation bands of BBr. E. ROSENTHALER. *Helv. Phys. Acta,* **13,** 5, *pp.* 355–380, 1940. *In German.*—The band spectrum of BBr has been measured with a 6m. grating, and it was possible to resolve, partly, the rotation bands. A method is developed to allocate the correct quantum numbers to each branch, and the rotation constants are determined by the usual graphical methods. They yield a nuclear distance of 1·87Å and 1·89Å for the $^1\Pi$ state and the $^1\Sigma$ state, respectively. Dissociation energies are determined by extrapolation, and it is confirmed that the dissociation of the normal molecule results in 2 atoms in normal states. R. P.

605. Band spectrum of GeS in emission. R. F. BARROW. *Proc. Phys. Soc., Lond.*, **53,** *pp.* 116–119, *March*, 1941.—The band spectrum of GeS, hitherto known only in absorption, has been excited in emission by means of a heavy-current uncondensed discharge through a mixture of S and GeO_2 contained in a silica tube in presence of Al. Some 20 new bands lying in the region λ 3 350–3 750 have been measured and assigned to the long-λ end of the main ($A \rightleftarrows X$) system of GeS. Analysis of the data on higher vibrational levels of the ground state derived from these bands confirms the values of ω_e'' and $x_e''\omega_e''$ previously determined from measurements of the system in absorption. AUTHOR.

606. Potential-energy functions for diatomic molecules. H. M. HULBURT AND J. O. HIRSCHFELDER. *J. Chem. Phys.*, **9,** *pp.* 61–69, *Jan.*, 1941.—The usual Morse functions are determined from the energy of dissociation, the equilibrium separation of the nuclei and the fundamental vibration frequency. Two additional spectroscopic constants are available for most of the common diatomic molecules and permit of adding a 2-parameter correction term. Both the potential and the extended Morse curve agree with accurate potentials in those cases where they are known. The constants for the first of these potentials are given for 25 common diatomic molecules. With only a few exceptions the improved potentials lie above the Morse curves and the corrections for moderately large internuclear separations may amount to 10% of the energy of dissociation. AUTHORS.

607. Spectrophotometric study of thionine. L. F. EPSTEIN, F. KARUSH AND E. RABINOWITCH. *J. Opt. Soc. Amer.*, **31,** *pp.* 77–84, *Jan.*, 1941.—Absorption spectra of 4 forms of thionine and 3 of leucothionine have been investigated over the range 230–970 mμ as functions of concentration. An attempt to identify the bands of semithionine in moderately acid solution was unsuccessful. Thionine follows Beer's law in solutions containing the free base and trivalent ions. Solutions of the monovalent ion $Thio^+$, on the other hand, show large deviations even at concentrations as low as 10^{-6} mole/l. A. H.

608. Establishment of precise spectrophotometric constants for hemochromogens and cytochrome C upon an iron basis, and the analysis of the cytochrome C spectrum. D. L. DRABKIN. *J. Opt. Soc. Amer.*, **31,** *pp.* 70–72, *Jan.*, 1941.—To standardize spectrophotometric constants for hemoglobin and its close derivatives the determination of iron is carried out in order to provide a basis. In addition, the visible and ultra-violet absorption spectrum of cytochrome C has been determined and the absorption curve analysed. A. H.

609. Measurement of fast reactions by absorption spectrophotometry and its application to respiratory enzyme kinetics. F. KARUSH. *J. Opt. Soc. Amer.*, **31,** *pp.* 73–76, *Jan.*, 1941.—A description is given of a technique which has been developed for the study of rapid chemical reactions using a high-speed automatic recording absorption spectrophotometer. A. H.

610. Zeeman effect of Xe. J. B. GREEN, E. H. HURLBURT AND D. W. BOWMAN. *Phys. Rev.*, **59,**

pp. 72–74, *Jan.* 1, 1941.—Measurements of the Zeeman effects of about 125 lines in the spectrum of XeI have been made. The *g* sum rule is violated by both of the completely known configurations and in some cases may be accounted for by configuration interaction. For other configurations, where only the lower levels are known, the *J* of the core is shown to be a good quantum number. AUTHORS.

611. New arrangement for accurate photo-electric spectral photometry, and the determination of the constants of an optical absorption wedge. Z. KOANA, T. MURAKAMI, K. AKIYAMA AND N. YAMAZAKI. *Proc. Phys.-Math. Soc. Japan,* **22,** *pp.* 940–967, *Nov.,* 1940. *In German.*—A method of determining the transmission of a light filter by a new arrangement for photo-electric spectrophotometry is described. The error involved in the method is less than 0·1%. A. J. M.

∗612. Specifications and testing of spectrochemical apparatus. R. A. SAWYER AND H. B. VINCENT. *J. Opt. Soc. Amer.,* **31,** *pp.* 47–53, *Jan.,* 1941.—A survey article which discusses the design and testing of apparatus for industrial spectrochemical analysis. The treatment is limited chiefly to equipment for emission work, although some of the equipment discussed is also usable in absorption work. A. H.

∗613. New projection comparator-densitometer. H. W. DIETERT AND J. SCHUCH. *J. Opt. Soc. Amer.,* **31,** *pp.* 54–57, *Jan.,* 1941.—Details are given of a densitometer which provides dual projection of a sample spectrogram and a master on to a translucent screen mounted directly before the operator. Using a slit system that moves into contact with the plate, a vacuum photocell, a 2-stage compensated amplifier and sturdy ammeter, the densitometer provides transmission readings on any spectral line, accurate to a few tenths p.c. The unit is fast in operation, up to 6 lines/min. can be read. A. H.

See also Abstract 583.

TRANSMISSION.

614. Chemical methods for increasing the transparency of glass surfaces. F. L. JONES AND H. J. HOMER. *J. Opt. Soc. Amer.,* **31,** *pp.* 34–37, *Jan.,* 1941.—Valuable increases in the light transmission of optical systems can be produced by suitable chemical treatment to form surface films of low refractive index. By following the chemical treatment with a baking operation the durability of the glass surface can be greatly increased. AUTHORS.

615. Photometric determination of K with dipicrylamine. E. AMDUR. *Industr. Engng Chem.* (*Analytical Edition*), **12,** *pp.* 731–734, *Dec.* 16, 1940.—The Kolthoff-Bendix method is modified by using Li dipicrylaminate solution in water saturated at 25° with K dipicrylaminate, and the method depends on comparing the % light transmission of the unknown sample with that of solutions of known concentration of reagent, using various appropriate light filters in each case. Reference curves and data are given. The method can be used for physiological determinations of K in presence of large amounts of Na. N. M. B.

VISION.

616. Sensitivity of the eye to small colour differences. W. D. WRIGHT. *Proc. Phys. Soc., Lond.,* **53,** *pp.* 93–112, *March,* 1941.—The paper records the measurement of small colour steps for various lines across the C.I.E. colour chart. The whole area of the chart has been covered by the author in a series of observations on 35 lines in various directions on the chart, and 6 of the more important lines have also been tested by three other observers. The results are illustrated graphically by a series of short lines of the appropriate length drawn on the colour diagram and they are also tabulated. The very wide variation in size of step in different parts of the C.I.E. chart is demonstrated. The results have been transformed to the rectangular uniform-chromaticity system of Breckenridge and Schaub, and a much closer approximation to equality in the length of step is apparent, although a considerable discrepancy still exists in the red corner of the chart. The application of the results to the specification of colour tolerances and to the adoption of an agreed uniform chromaticity scale is discussed. AUTHOR.

617. Fundamental principles of vision in very weak light. W. D. WRIGHT. *Trans. Illum. Engng Soc., Lond.,* **6,** *pp.* 23–30, *Feb.,* 1941.—A scale of subjective brightness is proposed in terms of which the changes in sensitivity of the eye can be recorded. The unit of subjective brightness is called a " brill," and it is suggested that the scale may also prove satisfactory as a means of specifying contrast. An experiment is described which enables the changes taking place during dark adaptation to be appreciated in a very striking manner and by means of which the time required to adapt down to low levels of adaptation other than complete dark adaptation can be recorded. The effect of area on visibility is briefly discussed and the action of a glare source in depressing the sensitivity of the eye and delaying its recovery is described. A short discussion of the extent to which contrast is affected by a reduction both of illumination and of area follows, after which a new test for defective night vision is described and some preliminary results reported. In the final section a brief description of a portable binocular matcher that can be used as a " brillmeter " to measure subjective brightness is given. AUTHOR.

X-RAYS.

618. Diffuse X-ray diffraction max. observed by Raman and Nilakantan. W. H. ZACHARIASEN. *Phys. Rev.*, **59**, *pp.* 207–208, *Jan.* 15, 1941.—Having measured some diffuse spots on Laue photographs the author concludes that there seems to be no acceptable basis for the assertion that the theory of diffuse scattering is incapable of giving the correct positions of the diffuse maxima. ED.

619. Fluorescent *K* X-rays from ions in solution and from gases. T. M. SNYDER. *Phys. Rev.*, **59**, *pp.* 168–170, *Jan.* 15, 1941.—The $K\alpha$ lines emitted by Co, Ni, Cu and Br contained in chemical compounds were compared with the lines emitted by these elements in pure form. Chemical combination was found to broaden the lines and increase their asymmetry. The magnitude of the effect was greatest for Co, progressively smaller for Ni and Cu and completely unobservable in the case of Br. The further effect on the $K\alpha_1$ lines of putting these compounds into water solution at various concentrations was studied. It was found that the lines were unchanged by solution regardless of the dilution. Finally, the $K\alpha$ doublets of liquid and gaseous Br were studied and found to be identical, showing that the state of physical aggregation has no effect on the $K\alpha$ lines of this element. AUTHOR.

620. X-ray spectra arising from the valence band—*L* transitions of W, WO_3 and Pt. J. A. BEARDEN AND T. M. SNYDER. *Phys. Rev.*, **59**, *pp.* 162–168, *Jan.* 15, 1941.—The X-ray emission lines and absorption edges were studied with a double-crystal spectrometer. Manning and Chodorow's calculation of the density of states in the 5*d* and 6*s* bands of W is found to be in good agreement with the observed shapes of the absorption edges. The emission lines, on the other hand, do not have the structure expected from their calculation and are 4·5 eV narrower than the region of occupied states calculated for these bands. A comparison of the spectra of W metal with those of its oxide shows : (1) the initial absorption max. of the L_{II} and L_{III} edges is both broader and higher in the oxide, (2) the *L* edges of the oxide are shifted 2·5 eV to higher frequencies, (3) the emission lines of the oxide are about 3 eV wider than those of the metal. These differences between the spectra of the oxide and the metal are explained qualitatively in terms of the high electro-negativity of oxygen. The Pt absorption edge structures observed are in agreement with what is qualitatively expected from the other properties of this metal. A marked difference in the relative intensity of corresponding structure features of the L_{II} and L_{III} edges is ascribed to a spin-orbit coupling of the valence electrons. AUTHORS.

HEAT.

CALORIMETRY.

***621. Calorimetric investigations of organic reactions.** J. M. STURTEVANT. *J. Phys. Chem.*, **45**, *pp.* 127–147, *Jan.*, 1941.—An adiabatic calorimeter of novel design is described. With this it is possible to determine, for homogeneous reactions in the liquid phase having half-times greater than about 10 min., the heat and velocity of reaction and the heat of mixing of the reactants. Heat measurements may also be made on very rapid processes. The apparatus has been tested by observations of the mutarotation of α- and β-*d*-glucose at 25°C. and 35°C., the results obtained agreeing satisfactorily with previous values where such exist. AUTHOR.

CONDUCTION.

622. Unsteady flow of heat through porous media. W. D. HARBERT, D. C. CAIN AND R. L. HUNTINGTON. *Industr. Engng Chem.*, **33**, *pp.* 257–263, *Feb.*, 1941.—The data presented in connection with this investigation will serve as a guide for the engineer who plans to heat porous media on a larger scale. The experimental work gives an idea of the relative rates of heat flow through the porous material, depending on the nature of the fluid filling the pore spaces. Further, the results indicate that conduction controls to a certain degree for small size grains, while convection controls for spheres of larger size, if the interstices are filled with liquid. The presence of dissolved air in the water and oil may have been the cause for apparent conductivities higher than those for the pure materials. AUTHORS.

TEMPERATURE.

***623. Multiple-unit recorder capable of 600 measurements per hr.** T. T. WOODSON. *Gen. Elect. Rev.*, **43**, *pp.* 512–514, *Dec.*, 1940. [Abstr. 365 B (1941).]

∗ 624. Adjustable mercury-filled metal thermo-regulator. F. Padgitt. *Industr. Engng Chem.* (*Analytical Edition*), **13,** *p.* 60, *Jan.* 15, 1941.—Describes a laboratory-made thermo-regulator comprising a welded steel tube construction with a screwed plunger as regulator for controlling the volume of mercury to change the temperature setting. The mercury may be displaced to cover a temperature range of about 90°C. When used with a suitable relay a constancy of temperature of 0·001°C. is claimed. E. H. W. B.

THERMOCHEMISTRY.

625. Thermal reaction between hydrogen and oxygen. II. Third explosion limit. O. Oldenberg and H. S. Sommers, Jr. *J. Chem. Phys.*, **9,** *pp.* 114–117, *Jan.*, 1941.—[See Abstr. 2482 (1940).] The thermal high-pressure explosion of the hydrogen-oxygen mixture occurring near atmospheric pressure at 560°C. was studied. In the P/T diagram a section of the limiting curve was determined. The effect of a KCl coat on a pyrex surface was observed. The investigation of the third explosion limit does not lend itself to a decision between the competing theories of the thermal hydrogen-oxygen reaction. Authors.

THERMODYNAMICS.

626. Inter-atomic potential curve and the equation of state for A. O. K. Rice. *J. Amer. Chem. Soc.*, **63,** *pp.* 3–11, *Jan.*, 1941.—The characteristic temperature and the total energy of the solid are expressed in terms of the constants of the potential expression, and the condition for equilibrium is set up and applied in the determination of the potential curve for A from experimental data. The effect of pre-melting is considered, the effect of the distribution of the frequencies of the normal modes of vibration of the solid upon its physical properties is discussed and the effect of possible deviations from the Debye theory estimated. Finally, it is shown that the potential curve obtained reproduces the experimental values of the second virial coefficient of the gas. Author.

627. Generalized equation for activity coefficients of gases. S. H. Maron and D. Turnbull. *Industr. Engng Chem.*, **33,** *pp.* 246–248, *Feb.*, 1941.—A general equation for all gases is derived, giving the activity coefficient of the gas as a function of the reduced temperature, T_r, and reduced pressure, P_r, only. Activity coefficients calculated from this equation are compared with activity coefficients read from Newton's generalized curves at various reduced temperatures and pressures. The agreement between the calculated activity coefficients and those read from Newton's curves is good at values of $T_r = 1{\cdot}3$ and above and at values of $P_r = 12$ and below. At values of T_r below 1·3 the agreement is good only at low values of P_r. Authors.

∗ 628. Thermodynamic study of the system $ZnSO_4$-H_2SO_4-H_2O at 25°C. H. V. Tartar, W. W. Newschwander and A. T. Ness. *J. Amer. Chem. Soc.*, **63,** *pp.* 28–36, *Jan.*, 1941.—The activities of each component of the system $ZnSO_4$-H_2SO_4-H_2O (conc. $ZnSO_4$ 0·5 to 2·0 M, H_2SO_4 0·1 to 4 M) were determined experimentally by measurement of the vapour pressures of the solutions and by measurement of the e.m.f.'s of the cells $H_2/H_2SO_4(m_1), ZnSO_4(m_2)/Hg_2SO_4/Hg$; $Zn/H_2SO_4(m_1), ZnSO_4(m_2)/Hg_2SO_4/Hg$. A dynamic vapour-pressure apparatus of improved design has been built and used. The changes in free energy for the reaction $ZnSO_4 + H_2O \rightarrow Zn + H_2SO_4 + \frac{1}{2}O_2$ in this series of solutions is computed. Authors.

ACOUSTICS.

629. Perturbation of boundary conditions. H. Feshbach and A. M. Clogston. *Phys. Rev.*, **59,** *pp.* 189–194, *Jan.* 15, 1941.—The perturbation method of solving boundary value problems with irregular boundary conditions is re-examined and generalized. Problems are considered for which the boundary of the region is changed and the boundary conditions are unaltered, and also the inverse case where the boundary is fixed and the boundary conditions are changed. An application of the method is made to a problem in room acoustics which requires the calculation of second-order terms in the perturbation, and the results obtained for the pressure distribution and frequency check well with esperiment. A simple formula is found for the problem of the absorbing wall. The method is useful in calculating electromagnetic resonators. The method is applied to the scattering problem, and the results are related to Huygen's principle. Authors.

630. New method for calculation of cavity resonators. W. C. Hahn. *J. Appl. Phys.*, **12,** *pp.* 62–68, *Jan.*, 1941.—This article gives a series method for the calculation of the fields in certain circularly symmetric resonators. By the use of some new functions, partial tables of which are included, the necessary series are made to converge rapidly enough so that the method becomes useful for numerical calculations of resonance conditions and wall currents. Author.

See also Abstract 443.

ELECTRICITY AND MAGNETISM.

ALTERNATING-CURRENT NETWORKS.

631. Circuits with double linkages. E. A. Walker. *Phil. Mag.*, **31,** *pp.* 169–176, *Feb.*, 1941. [Abstr. 353B (1941).]

CONDUCTION IN SOLIDS AND LIQUIDS.

632. Electrical resistance of polycrystalline Au, Pb, Nb and Ta under strong magnetic crossfields at low temperatures. E. Justi. *Phys. Z.*, **41,** *pp.* 486–498, *Nov.* 15, 1940. *In German.*—According to the theory of metallic conduction it was to be expected that Au tested under the conditions stated would show a saturation value of the relative change of resistance considerably larger than unity. Measurements show that this holds true and that there are deviations from Kohler's as well as from Nernst-Matthiessen's rules. Pb as a divalent element shows an accelerated, strong and unlimited rise of the relative resistance change similar to that of the metals contained in the 2nd and 6th column of the periodical system. Ta and Nb show a very small rise in resistance, in fact the resistance of Nb is practically independent of the field. During the measurements special care was taken to insure the absence of paramagnetic O_2 in the low-temperature bath. R. N.

633. Conduction of electricity by dielectric liquids at high field strengths. H. J. Plumley. *Phys. Rev.*, **59,** *pp.* 200–207, *Jan.* 15, 1941.—The conductivity of highly purified heptane has been measured between optical flats at field strengths up to 600 kV/cm. and at temperatures ranging from − 190° to 20°C. Electrode separations down to 0·005 cm. were used in order to minimize the effect of space charge and ionic recombination. It is concluded that electronic or collision processes are unlikely as the source of high field conductivity in heptane and probably most other liquid dielectrics as well. It is suggested that the highly non-conducting dielectric liquids should be included as extreme cases in the general class of weak electrolytes. The presence of appreciable conductivity under high electric fields is ascribed to the lowering of the energy of the H-bond by the applied field. Author.

634. Phase segregation and its relation to the properties of the system Pd-H. D. P. Smith. *Trans. Electrochem. Soc.*, **78,** *pp.* 117–130, 1940. —Upon experimental evidences the system Pd-H is shown to differ from the ordinary binary metallic system in that its two solid phases, within the range of compositions where both are present, do not form an aggregate but are wholly segregated. It is further shown that this fact accounts for anomalies in the 2 best-studied properties of the system, its dissociation tension and its electrical conductivity. Author.

635. Reversal of rectification by heat in crystal contacts and its analogy to a thermo-electric phenomenon. M. A. El Sherbini and Y. L. Yousef. *Proc. Phys. Soc., Lond.*, **53,** *pp.* 120–125, *March*, 1941.—The reversal of rectification previously observed by the authors in molybdenite-copper contacts at low temperatures led them to expect reversal in other rectifying crystals when the temperature is changed over a wide range. Experiments on bornite show that, for voltages less than 1 V, reversal occurs below 200°C. Silicon is expected to reverse at some temperature below − 75°C. for potential differences of the order of several volts. The analogy between the behaviour of rectifying crystals towards heat and the behaviour of a thermocouple whose cold junction is maintained at different temperatures suggests that the rectifying action may be, at least in part, of a thermo-electric origin. Authors.

See also Abstract 458.

DIELECTRICS AND CAPACITANCE.

636. Theory of the transition in KH_2PO_4. J. C. Slater. *J. Chem. Phys.*, **9,** *pp.* 16–33, *Jan.*, 1941.—KH_2PO_4 contains phosphate groups connected by H-bonds. Different possible arrangements of the hydrogens result effectively in different orientations of the $(H_2PO_4)^-$dipoles. Since these have the lowest energy when pointing along the axis of the crystal, there is a tendency toward spontaneous polarization along this axis, resulting in the well-known transition with polarization below the Curie point. The theory of this transition is worked out, using statistical methods to count the number of arrangements of hydrogens consistent with each total polarization of the crystal and deriving the free energy. The theory predicts a phase change of the first order with sudden transition from the polarized state at low temperature to the unpolarized state at high temperature. Author.

637. Induction, resonance and dipole moment. C. P. Smyth. *J. Amer. Chem. Soc.*, **63,** *pp.* 57–66, *Jan.*, 1941.—Dipole moments determined in the vapour state for alkyl chlorides and nitroparaffins are used together with those already in the literature to extend or strengthen previous conclusions as to the extent of inductive effects in straight and branched chains. Differences in chemical reactivity between halogens or hydrogen on primary, secondary and tertiary C atoms are not reflected in detectable differences in moment. The effects of polar structures upon the moments are obscured by those of induction. Dipole moments measured in solution for halides containing Pb or Ge are used to calculate min. values for the Pb-Cl and Ge-Cl bond moments. These, together with a previously calculated Sn-Cl moment, and the moments of the NaI, KI and KCl molecules, are used to calculate percentages of ionic character in the bonds in fair agreement with percentages calculated from electro-negativities obtained from thermal data. The dipole moments of the 4 mono-halogenated benzenes are used to calculate the fractions of double-bend character in the carbon-halogen bonds in these molecules. The results are lower than those obtained from the carbon-halogen bond lengths given by electron diffraction. The relative accuracy of values obtained from moments for more or less similar substances is greater than that obtained by the use of inter-atomic distances. H. H. Ho.

638. Dielectric measurements on suspensions of pigments in linseed oil. F. Wachholtz and A. Franceson. *Kolloid Zschr.*, **92**, *pp.* 75–93, *July*, *and pp.* 158–169, *Aug.*, 1940. *In German.*—The principle of the apparatus used for determining the permittivity of solids, liquids and suspensions consists in tuning to resonance an oscillatory circuit and a measuring circuit in which a condenser, containing as dielectric the substance to be measured, is connected in parallel with 2 variable condensers for coarse and fine regulation. By these means the permittivity of pigments suspended in linseed oil with different degrees of concentration have been measured. It appears that a satisfactory method for calculating the permittivity of such suspensions does not exist. Special stress is laid on the vectorial character of the permittivity. The authors use a method analogous to that described by Frey [Abstr. 3868 (1932)]. Not the size but the form of the suspended particles and the type of mixture are essential for the relation between permittivity and concentration. The type of mixture depends on whether the disperse phase or the dispersion medium has the larger permittivity. The results are compared with values calculated from formulae proposed by previous authors. R. N.

639. Dielectric properties of protein solutions. J. D. Ferry and J. L. Oncley. *J. Amer. Chem. Soc.*, **63**, *pp.* 272–278, *Jan.*, 1941.—The dielectric constants of solutions of lacto-globulin in 0·25 and 0·50 *M* glycine have been measured at 0° and 25°C. over a frequency range of 10000 to 5000000 c./s. The l.f. dielectric increments/g./l., extrapolated to zero concentration, are in both solvents 1·51 at 25° and 1·84 at 0°C. These figures diminish with increasing concentration. The dipole moments are estimated to be 730 Debye units at 25° and 770 at 0°. The mean mid-point frequency is approximately proportional to the ratio of absolute temperature and relative viscosity of the solvent. The dispersion curves have been analysed and the results compared with those obtained from ultra-centrifuge, diffusion and viscosity measurements. All these data can be interpreted in terms of an elongated ellipsoidal molecule of axial ratio (a/b) 4 and hydration 0·3 g. of water per g. of protein. Authors.

ELECTROCHEMISTRY

640. Study of the kinetics of the reactions in the Zn/H irreversible cell. J. I. Jolley and H. V. Tartar. *Trans. Electrochem. Soc.*, **78**, *pp.* 207–227 ; *Disc.*, 227–229, 1940.—An apparatus was devised for determining the rate of metal/acid reactions in which the metal is made the anode of a metal/hydrogen irreversible cell. Using this type of cell, a study was made of the kinetics of the dissolution of Zn in aqueous solutions of acids as affected by different factors such as electrolyte used, rotation of metal, temperature and cell resistance. The similarity between the Zn/H irreversible cell and local couples is discussed. The rate of solution of Zn in acids is inversely proportional to the resistance of the solution, the resistance in the external circuit between the Zn and the Pt electrodes, and to some function of the acid concentration. Authors.

641. Electrochemical methods in microchemistry. E. B. Ashcraft. *Trans. Electrochem. Soc.*, **78**, *pp.* 63–73 ; *Disc.*, 73–75, 1940. [Abstr. 330B (1941).]

642. Sorting of mixed solvents by ions. G. Scatchard. *J. Chem. Phys.*, **9**, *pp.* 34–41, *Jan.*, 1941.—The electrostatic interaction of ions with non-electrolytes is computed for ethanol-water mixtures over the whole composition range by the Debye treatment which takes into consideration the heterogeneity of the solvent. A simple approximate relation is derived which may be extended to other solvents. Author

643. Electrolytic determination of Cu in steel. H. A. Frediani and C. H. Hale. *Industr. Engng Chem.* (*Analytical Edition*), **12**, *pp.* 736–737, *Dec.* 16, 1940.—The method involves fairly rapid dissolution of the sample steel with the addition of phosphate or fluoride ion to tie up any ferric ion that may be formed. The resultant solution is then electrolysed at a rather high current density with a special cell for temperature control to a low value. Satisfactory results on samples with a wide range of Cu concentrations are obtained. Since the Cu may be plated without previous chemical separation, lengthy filtration of hydroxide or sulphide precipitates is obviated. N. M. B.

644. Hydrogen and oxygen overvoltages of Cr-Ni alloys in 1 molal KOH. M. DE K. THOMPSON AND G. H. SISTARE, JR. *Trans. Electrochem. Soc.*, **78**, *pp.* 259–263, 1940.—The relation between H overvoltage and alloy composition is not linear for the whole range of composition, and has no relation to the m.p. diagram. However, the relation between H overvoltage and the log of the current density is nearly linear in all cases. The O overvoltage could not be determined for alloys containing as much as 18·74% Cr and over; therefore, this was determined for only one alloy containing 10·68% Cr. AUTHORS.

645. Overvoltage and structure of the electrical double layer at a hydrogen electrode. G. E. KIMBALL, S. GLASSTONE AND A. GLASSNER. *J. Chem. Phys.*, **9**, *pp.* 91–96, *Jan.*, 1941.—The question arises whether the actual potential at the electrode or the overvoltage is to be used in the equation for the specific rate of discharge of ions. In the case of H-ion discharge it is found experimentally that the overvoltage should be used; the theory in its simplest form requires the total potential. This paradox can be resolved by postulating the existence of 2 different electrical double layers at the electrode surface and 2 corresponding energy barriers. Provided the barrier nearer the electrode is the higher, the overvoltage is essentially established across this layer, while the variation in equilibrium potential caused by variations in the H-ion concentration of the solution is established across the outer double layer. Since the rate of discharge is determined by the potential difference across the inner double layer, the rate is determined by the overvoltage. AUTHORS.

646. Mechanism of the glass electrode. G. HAUGAARD. *J. Phys. Chem.*, **45**, *pp.* 148–157, *Jan.*, 1941.—The transference of electricity through glass under conditions approximating those under which the glass electrode works has been studied. The mechanism of the glass electrode has been in part elucidated by experiments with electrodes, the glass membranes of which were in equilibrium with the surrounding solution only on one side. The H-ion uptake of glass surfaces has been measured in connection with the absorption of water. Experiments with alcohol-water absorption are reported. The theory of the glass electrode is discussed on the basis of the experimental results given. AUTHOR.

647. Hydrogen anode. M. DE K. THOMPSON AND H. V. FAIRBANKS. *Trans. Electrochem. Soc.*, **78**, *pp.* 163–171, 1940. [Abstr. 335B (1941).]

648. Metallized glass oxygen electrodes. H. G. BAIN. *Trans. Electrochem. Soc.*, **78**, *pp.* 173–189, 1940. [Abstr. 336B (1941).]

649. Electrochemical potential differences at the boundary copper/insulating-liquids. A. GEMANT. *Trans. Electrochem. Soc.*, **78**, *pp.* 49–61, 1940. [Abstr. 334B(1941).]

650. Amperometric titrations. I. M. KOLTHOFF. *Trans. Electrochem. Soc.*, **78**, *pp.* 191–206, 1940.—[See Abstr. 876 (1940).] In amperometric titrations the current passing through the titration cell is measured. Characteristic current/voltage curves are shown. AUTHOR.

See also Abstracts 452, 453, 454.

ELECTRONS, NEUTRONS, POSITRONS AND PROTONS.

651. Nuclear potential of the deuteron. G. KNIE. *Publ. Fac. Cienc. Fís.-Mat. La Plata, No.* 136, *pp.* 329–337, *Oct.*, 1940. *In Spanish.*—Following Bethe's method [Abstr. 1329 (1940)] the author deduces the potential energy of 2 nuclear particles under the assumption that the meson is the cause of this energy. Maxwell's equations lead to an expression for the vector potential of the meson, and this is also obtained as the Hamiltonian of the meson field. ED.

652. Excited states of nuclear particles in the meson-pair theory. C. L. CRITCHFIELD. *Phys. Rev.*, **59**, *pp.* 48–52, *Jan.* 1, 1941.—A meson-pair theory of nuclear forces is considered in which it is not necessary to use perturbation calculations. Former results in this theory are improved. New considerations are found necessary if the interaction between heavy particle and meson field is large enough to form bound meson states. For such large interactions discrete stationary states of neutron and proton exist, some of which have higher or lower charge and spin than the normal states. The energy required to excite the higher discrete states is of the order of the rest energy of the meson. AUTHOR.

653. Positrons from light nuclei. M. G. WHITE, E. C. CREUTZ, L. A. DELSASSO AND R. R. WILSON. *Phys. Rev.*, **59**, *pp.* 63–68. *Jan.* 1, 1941.—Four nuclei of the type discussed by Wigner, containing one more proton than neutron, have been produced. The nuclei, their half-lives and positron energies, are; P^{29}, 4·6 sec., 3·63 eMV; S^{31}, 3·2 sec., 3·85 eMV; Cl^{33}, 2·4 sec., 4·13 eMV; A^{35}, 2·2 sec., 4·38 eMV. These energies agree with the calculated values and indicate that (1) the $\pi - \pi$ force is equal to the $\nu - \nu$ force plus the Coulomb repulsion, (2) the nuclear volumes are proportional to the atomic weights and (3) the nuclear charge is distributed uniformly through the volume. The half-life-energy relation is in good agreement with the Fermi theory. Deviations are in the direction anticipated by the Gamow-Teller modification. AUTHORS.

654. Note on the density and compressibility of nuclear matter. E. Feenberg. *Phys. Rev.*, **59,** *pp.* 149–150, *Jan.* 15, 1941.—The influence of the Coulomb force between protons on nuclear radii is calculated by using the min. property of the energy eigenvalue. Several different methods of estimating the compressibility of nuclear matter yield qualitatively concordant results. A small correction to the Coulomb energy is required by the finite value of the compressibility. This correction, which may be called the Coulomb " expansion " energy, is proportional to the square of the Coulomb energy. Author.

655. Sputtering and secondary electron emission of metals bombarded by argon ions. G. Timoshenko. *J. Appl. Phys.*, **12,** *pp.* 69–77, *Jan.*, 1941.—A method has been devised for accurate determination of the absolute rate of sputtering, i.e. the measurement of the number of atoms liberated from a metallic target under the impact of a single ion of known energy. The accuracy of this measurement was 6 to 7%. The apparatus producing A ions consisted of a strong ion source of capillary-arc type. The ions were accelerated within a high-vacuum chamber through a potential which was varied from 2000 to 7000 V, and then allowed to strike a metallic target. The sputtering rate was determined by measuring the positive ion current to the target and the loss of target material. Results are given on sputtering of Ag by A and on the secondary electron emission from Al and Mo. Author.

656. Angular distribution of fast neutrons scattered by atoms. I and II. S. Kikuchi, H. Aoki and T. Wakatuki. *Coll. Pap. Fac. Sci., Osaka Imp. Univ. B*, **7,** 1939.—[Abstr. 4145 (1939) and 884 (1940).]

657. Scattering of fast neutrons. H. Aoki. *Coll. Pap. Fac. Sci., Osaka Imp. Univ. B*, **7,** 1939.—[Abstr. 3427 (1939).]

658. Scattering of neutrons. S. Kikuchi and T. Wakatuki. *Coll. Pap. Fac. Sci., Osaka Imp. Univ. B*, **7,** 1939.—[Abstr. 1922 (1940).]

659. Protons of double charge and the scattering of mesons. H. J. Bhabha. *Phys. Rev.*, **59,** *pp.* 100–101, *Jan.* 1, 1941.

660. Polarization of electrons by double scattering. H. S. W. Massey and C. B. O. Mohr. *Proc. Roy. Soc. A*, **177,** *pp.* 341–357, *Feb.* 24, 1941.—The scattering of electrons by Au, Xe and Kr atoms has been investigated using Dirac's equations. The polarization to be expected by double scattering at 90° has been studied for an energy range 100 to 150000 eV. The results agree substantially in the energy range 10000-150000 eV with those obtained by Mott for an unscreened gold nucleus. It is found, however, that for lower energies the effect of screening is more important. In particular, at energies for which the intensity of single scattering at 90° is near a min., a large polarization is to be expected in the case of Au. For Xe the polarization never exceeds 4% and for Kr 2%. Modifications of the interaction between a nucleus and electron which would reduce the polarization are considered. As an example of a field as different as possible from the Coulomb type, the polarization produced in double scattering by a potential "well" is investigated in detail. Authors.

661. Investigation of the disintegration of B by slow neutrons. R. S. Wilson. *Proc. Roy. Soc. A*, **177,** *pp.* 382–392, *Feb.* 24, 1941.—The disintegration of B by slow neutrons has been investigated using an ionization chamber filled with BCl$_3$ in conjunction with a linear amplifier. The magnitides of the ionization impulses, measured by the oscillograph deflections, should give under appropriate conditions a measure of the energy release in the disintegration process. The various factors which can affect the size of the oscillograph deflection are discussed so as to define the appropriate conditions of experiment. Evidence is found for 2 disintegration energies. Assuming that the greater energy release corresponds to the formation of the Li^7 nucleus in the ground state and is therefore 2·99 eMV, the smaller energy, which is released in about 93-94% of the disintegrations, is $2{\cdot}57 \pm 0{\cdot}05$ eMV. An explanation is offered of the contradiction with the results of Maurer and Fisk. The γ-radiation associated with the reaction has been detected and a rough measurement of its quantum energy has been made. Author.

662. After-effect of metal bombarded by electrons. M. Tanaka. *Proc. Phys.-Math. Soc. Japan*, **22,** *pp.* 899–924, *Nov.*, 1940.—When a metallic surface is bombarded by electrons there is a delayed electron emission. The effect of time of bombardment, bombardment current, potential and surface condition, of the metal on the intensity of the effect is investigated. There is a close relation between the secondary electron emission and the effect. The effect is observed on the surface of almost all metals. A. J. M.

663. Phase shift in deuteron-deuteron scattering. E. Kuronuma, S. Suboka and T. Toya. *Proc. Phys.-Math. Soc. Japan*, **22,** *pp.* 862–863, *Oct.*, 1940.—The data on the scattering of deuterons by deuterons are interpreted in terms of the phase shift and it is found that only the *S* wave is affected appreciably. The phase shift which is required in order to describe the experiments could be obtained by means of an attractive 'square well' potential of 18·2 eMV depth and $4{\cdot}2 \times 10^{13}$ cm.

range, or, alternatively, by a repulsive potential of 13·6 eMV with the same range. R. P.

664. Excitation of metastable states of oxygen atoms by electron impact. T. Yamanouchi, T. Inui and A. Amemiya. *Proc. Phys.-Math. Soc. Japan*, **22**, *pp.* 847–854, *Oct.*, 1940.—The probability of excitation of oxygen atoms by electron impact is calculated. It is found that the probability is much larger than one would expect on the face of it, because of a particular resonance near 9 V for the transition $^3P \rightarrow {}^1D$. Therefore, it is possible to account for most of the spectrum of the night sky and of the Aurora by this process. R. P.

665. Scattering of mesons of spin $\frac{1}{2}\hbar$ by atomic nuclei. R. E. Marshak and V. F. Weisskopf. *Phys. Rev.*, **59**, *pp.* 130–133, *Jan.* 15, 1941.—The non-electric scattering of charged mesons by protons and neutrons is calculated as a first-order effect in the heavy-electron-pair theory of nuclear forces. An upper limit for the scattering cross-section of mesons by nuclear particles is derived ; the values obtained in the present paper agree with the upper limits of the scattering cross-section found experimentally by Wilson and others. For meson energies large compared with the rest energy of the proton or neutron the scattering cross-section increases linearly with the energy ; it first attains the value 10^{-26} cm^2. for meson energies of the order of 10^{11} eV. Authors.

666. Magnetic spectra of doubly scattered electrons. K. Kikuchi. *Sci. Rep. Tôhoku Univ.*, **29**, *pp.* 430–439, *Nov.*, 1940.—Using the apparatus previously described [Abstr. 281 (1941)], magnetic spectra in double scattering experiments by 2 Au targets or by a Au and an Al target were observed. Results are compared with those of Wagner [Abstr. 2287 (1930)], and the small asymmetry in Dymond's experiment on polarization [Abstr. 4560 (1932)] is discussed on the basis of magnetic spectra. N. M. B.

667. Double scattering of high-speed electrons by Au and Al targets. K. Kikuchi. *Sci. Rep. Tôhoku Univ.*, **29**, *pp.* 423–429, *Nov.*, 1940.—Using an apparatus previously described [Abstr. 281 (1941)], Au and Al were used as polarizer and analyser, respectively. The shape of the spectrum was similar to that for Al in right-angled scattering, but differed from that obtained with 2 Au targets, and the peak of the spectrum was found in a lower velocity range, the spectrum at an azimuthal angle of 0° nearly overlapping that at 180°. Hence there was no asymmetry as found in the case of 2 Au targets. N. M. B.

668. Determination of inner potential by electron reflection method. T. Yamaguti. *Coll. Pap. Fac. Sci., Osaka Imp. Univ. B*, **7**, 1939. [Abstr. 4392 (1939).]

669. Relative stopping powers of C and Pb for slow mesons. M. A. Pomerantz and T. H. Johnson. *Phys. Rev.*, **59**, *pp.* 143–148, *Jan.* 15, 1941.—For mesons having an average energy of approximately 4×10^7 eV the experiments revealed that 28·5 g./cm^2. of C is equivalent in stopping power to 24 ± 5 g./cm^2. of Pb. This gives a value for the ratio of the stopping powers, $S_c/S_{Pb} = 0{\cdot}84 \pm 0{\cdot}18$, compared with the theoretical value of $S_c/S_{Pb} = 1{\cdot}82$ calculated with the ionization theory. This discrepancy may be explained as arising from the scattering and transition effects. The corrected data show that 28·5 g./cm^2. of C is equivalent in stopping power to 45 ± 7 g./cm^2. of Pb, and $S_c/S_{Pb} = 1{\cdot}6 \pm 0{\cdot}3$, in agreement with the theoretical value. These experiments indicate that in a dense absorber any additional absorption process is unimportant compared with ionization for mesons having energies of about 4×10^8 eV, or higher. Authors.

670. Density distribution in the steady-state diffusion of neutrons. E. A. Uehling. *Phys. Rev.*, **59**, *pp.* 136–143, *Jan.* 15, 1941.—By the method of Laplace transformations an expression in closed form for the spatial distribution in density of diffusing particles is obtained. This derivation is valid both for the case of incident currents of particles upon the face of a half-infinite medium and for the case of source distributions within that medium. The final expressions are given in terms of a transcendental function and its zeros together with a definite integral, all of which require numerical evaluation. Author.

671. Absorption of resonance neutrons by B, Cl, Co and Mn. W. J. Horvath and E. O. Salant. *Phys. Rev.*, **59**, *pp.* 154–162, *Jan.* 15, 1941.—Measurements are made of the absorption of neutrons by several elements which capture the neutrons without activity (or with very weak activity). Rh, In, Ag, Mn, Br and I, were used as thermal and resonance detectors, and their known B absorption coefficients were redetermined more carefully. The resonance levels of only Rh and In appeared to be single. It is shown that, by comparing the B absorption coefficients with the absorption coefficients of the non-radioactive elements, resonance levels of those elements can be located : Resonances are found for Cl^{36} near 1 V, for Co^{58} near 1 and 30 V, for Mn below 0·4 V. Corrections for non-parallelism of the neutron beam are made semi-empirically and neutron scattering by the absorbers is shown to be quite small compared with neutron capture. Authors.

672. Production of proton beams. E. S. Lamar, W. W. Buechner and R. J. van de Graaff. *J. Appl. Phys.*, **12**, *pp.* 132–140, *Feb.*, 1941.—An account is given of further work [see Abstr. 3206

(1937)] on capillary ion sources of the diffusion type. Both metal and glass capillaries have been investigated. The performance of the metal sources is affected by surface conditions which are difficult to control. The average proton yield from these sources is about 10%. It was found that the yield could be increased to about 50% by coating the surface with P_2O_5. Sources constructed of pyrex have a proton yield of about 60% and greater stability in operation as well as certain other advantages. Various characteristics of the output of both types of source are described as functions of the source geometry, arc current, and other variables. AUTHORS.

***673. Experimental investigation of ion beam focusing.** W. W. BUECHNER E. S. LAMAR AND R. J. VAN DE GRAAFF. *J. Appl. Phys.*, **12,** *pp.* 141–148, *Feb.*, 1941.—An experimental investigation has been made of the initial focusing of ions from capillary sources of the diffusion type described in the previous paper. [Abstr. 672 (1941).] The lens system used consisted of a 90° cone at the ion source followed by 3 co-axial cylinders which were arranged at various potentials up to 25 kV. Since the beams are rendered slightly luminous by traces of gas in the high-vacuum region, they have been studied by photographic and electrical scanning methods. Both types of investigation were made as functions of the electrode potentials and arc variables and are in good agreement. Based on these observations a focusing and canal arrangement suitable for differential pumping has been tested. This arrangement has been embodied in a design for a projected ion gun assembly. AUTHORS.

674. Measurement of cathode emission by use of the electron microscope. G. W. FOX AND F. M. BAILEY. *Phys. Rev.*, **59,** *pp.* 174–178, *Jan.* 15, 1941.—The electron microscope has been used in connection with photographic technique to make quantitative measurements of electron emission from the oxides of Ba, Sr and Ca. The instrument proves to be an excellent emission comparator. Time lapse exposures allow the observation of activation processes in detail. The emitting properties of Ba compounds other than the oxide are compared. AUTHORS.

ELECTROSTATICS.

675. Determination of the axial potential distribution in axially symmetric electrostatic fields. S. BERTRAM. *Proc. Inst. Radio Engrs, N.Y.*, **28,** *pp.* 418–420, *Sept.*, 1940.—[Abstr. 163B (1941).]

676. Analysis of electrostatic and magnetic fields by the Schwarz-Christoffel transformation. S. YOH. *Nippon Elect. Commun. Engng, No.* 21, *pp.* 39–41, *July*, 1940.—[Abstr. 35B (1941).]

677. Tribo-electricity in wool and hair. A. J. P. MARTIN. *Proc. Phys. Soc., Lond.*, **53,** *pp.* 186–189, *March*, 1941.—When wool fibres (or hairs) are rubbed together, the sign of the tribo-electric charges produced depends upon the sense of the rubbing. This effect is due to the cuticle cells of the fibre, which are piezo- and pyro-electric. Pyro-electricity is absent or weak in the cortical cells. AUTHOR.

MAGNETISM AND ELECTRO-MAGNETISM.

678. Note on concentrated ferromagnetic amalgams. L. F. BATES. *Proc. Phys. Soc., Lond.*, **53,** *pp.* 113–115, *March*, 1941.—Attempts to obtain concentrated fluid amalgams of Ni and Hg are described. Concentrated amalgams formed by low-temperature distillation become ferromagnetic when their constitution reaches 3 atoms of Hg to 1 of Ni. AUTHOR.

679. Theory of antiferromagnetism. J. H. VAN VLECK. *J. Chem. Phys.*, **9,** *pp.* 85–90, *Jan.*, 1941.—Expressions for the susceptibility of a medium with antiferromagnetic exchange coupling are derived by means of the Dirac vector model. The formulae yield a Curie temperature, T_c, above which the internal field disappears and at which the susceptibility χ is a max. The calculated value of χ is $\frac{2}{3}$ as large at $T = 0$ as at $T = T_c$. This prediction accords with experimental data on MnO, but not on MnSe. In an antiferromagnetic medium the internal field should be treated as randomly directed, and the results may be regarded as generalizations of formulae previously obtained for inner fields perpendicular and parallel, respectively, to the applied field. A slight accentuation of the perpendicular alignment by very powerful applied fields explains the dependence of the susceptibility on field strength. AUTHOR.

680. Evidence for the existence of higher hydrates of ferric oxide as transition intermediates. L. A. WELO. *Phil. Mag.*, **31,** *pp.* 103–114, *Feb.*, 1941.

681. Diamagnetism of Ni triazene complexes. F. P. DWYER AND D. P. MELLOR. *J. Amer. Chem. Soc.*, **63,** *pp.* 81–83, *Jan.*, 1941.—Magnetic-susceptibility measurements show that Ni complexes of diazoaminobenzene and 4,4′-dimethyldiazoaminobenzene are diamagnetic and contain square co-ordinated Ni atoms. The only feasible formulation of these compounds as square co-ordinated complexes seems to be that in which the triazene group is made to function as a chelate group. AUTHORS.